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## Urogenital Schistosomiasis (UGS) and Female Genital Schistosomiasis (FGS) in Cameroon: An in-depth assessment of reproductive health determinants of girls and women in the Matta Health Area

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4 in-depth assessment of reproductive health determinants of girls and women in the Matta Health Area  
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3 **26 Abstract**  
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5 **27 Objectives and Setting:** Across sub-Saharan Africa, Urogenital Schistosomiasis (UGS), in particular  
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7 **28 Female Genital Schistosomiasis (FGS)** is a significant waterborne parasitic disease. FGS affects the  
8  
9 well-being of millions of girls and women, yet its direct burden upon sexual and reproductive health  
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11 (SRH), of sufferers is infrequently measured, as is the case in Cameroon. Our study therefore focused  
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13 upon FGS and sought to identify current associations with several key reproductive health indicators,  
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15 to provide formative information for better integrated control with UGS.  
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18  
19 **33 Participants:** From a population of 304 females all examined for UGS by urine filtration and  
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21 microscopy (UGS prevalence = 63.8%; 95% CI: 58.3–69), an unbiased sub-group of 67 girls and  
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23 women aged >13 was examined clinically for FGS. This included application of portable colposcopy,  
24  
25 a technique not available in routine primary care, with observed sequelae classified according to the  
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27 WHO FGS pocket atlas.  
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30 **38 Outcome:** Within this sub-group, the prevalence of FGS was 50.7% (34/67) and 59.7% (40/67) for  
31  
32 UGS, with most common FGS pathologies being abnormal blood vessels, homogenous yellow sandy  
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34 patches and grainy sandy patches.  
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37 **41 Results:** Epidemiological associations with FGS and UGS were investigated by univariate and  
38  
39 multivariate logistic regression analyses. In terms of age of sufferers, FGS increased significantly with  
40  
41 ascending age, whilst a non-significant decrease with descending age was observed for UGS. Of note,  
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43 girls and women with FGS exhibited increased menstrual abnormalities/irregularities (MI). Lower  
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45 abdominal pain (LAP) was identified as the only significant shared symptom of both FGS (AOR 9.5;  
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47 95% CI: 1.7–81.5) and UGS (AOR 4.3; 95% CI: 1.4–14.4), while LAP with MI appeared a strong  
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49 epidemiological flag for FGS.  
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52 **48 Conclusion :** LAP and MI provide two under-explored dimensions in SRH that could be exploited in  
53  
54 future for targetting of praziquantel provision to FGS sufferers within primary care, complementary  
55  
56 with existing distribution for UGS sufferers.  
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3 51 **Keywords:** *Schistosoma haematobium*, clinical colposcopy, questionnaires, menstrual health,  
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5 52 abdominal pain  
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## 10 54 **Key Messages**

### 11 55 **What is already known on this topic**

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15 56 - Whilst millions of women in Cameroon have UGS, its epidemiological connection with FGS is not  
16 57 fully appreciated, which creates an unfortunate knowledge bottleneck for effective control at the  
17 58 public health level  
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### 21 59 **What this study adds**

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23  
24 60 - A detailed insight into the connection of FGS and UGS within a primary care setting, denoting  
25 61 those with cardinal symptomologies more explicitly for scalable detection and targeted control of FGS  
26 62 within UGS endemic areas  
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28  
29

30 63 - Using clinical colposcopy combined with an analysis of sexual and reproductive health  
31 64 determinants, we develop a simple questionnaire approach which can better capture FGS sufferers  
32 65 within endemic areas for UGS  
33  
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### 36 66 **How this study might affect research, practice or policy**

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38 67 - Formative evidence is provided with initial recommendations, towards developing better national  
39 68 surveillance and control of FGS, thereby better empowering women's health within the Central  
40 69 African Region  
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## 78 **Introduction**

79 Urogenital schistosomiasis (UGS) and female genital schistosomiasis (FGS) although are both caused  
80 by infection with *Schistosoma haematobium*, a waterborne blood fluke, each appear to have rather  
81 obscure epidemiological associations, largely due to insufficient disease surveillance[1-3]. In sub-  
82 Saharan Africa where UGS is endemic and can be highly prevalent (>50%), insufficient or infrequent  
83 efforts have been undertaken to document FGS specifically, partly as the clinical skills to do so are  
84 bottlenecked within primary care[2]. While active UGS does not readily predict FGS, since FGS can  
85 occur without the direct presence of schistosome eggs in urine (a cardinal diagnostic for UGS[4]),  
86 rather FGS often presents with a more chronic time frame where schistosome eggs trapped within the  
87 cervico-vaginal surfaces[3, 5, 6]. For some, these trapped eggs can accumulate from very early on in  
88 life with enduring and typically hidden or cryptic sequelae[5, 7]. Based on several plausible biological  
89 determinants, the mucosal damage and fibrotic scarring of the vaginal and cervical surfaces from FGS  
90 proceeds with increasing duration of UGS infection(s)[3]; moreover, FGS-specific sequelae maybe  
91 slow to resolve upon standard antiparasitic treatment of UGS, i.e., single annual administration of  
92 praziquantel at 40mg/g as used in public health campaigns[3, 5].

93 In many parts of Africa where surveillance of UGS is poor and that for FGS is largely absent, there is  
94 a clear need to better understand the epidemiological associations between UGS and FGS. Particularly  
95 so to support earlier diagnosis of cases of FGS and individualize praziquantel treatment needs to better  
96 avert their disease progression; current interventions against UGS do not specifically target adolescent  
97 girls or women[8] though with the new WHO 2022 guideline, there is new encouragement to do so[9].  
98 This gap in treatment coverage also has considerable bearing on progress towards elimination of  
99 schistosomiasis transmission within disease endemic communities[9].

100 In recent years, FGS focused research and public health education[10] has gained traction in certain  
101 countries such as Ghana and Madagascar, although other countries ,such as Cameroon currently lag  
102 behind. Schistosomiasis exists in several regions of Cameroon affecting over 10 million people in  
103 rural and urban areas[11], and the country has a national coordinated control plan for fairly early  
104 interventions during child-hood years (from 5 – 14 years old). These take advantage of school based

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3 105 intervention platforms[12, 13] and in certain settings with community based interventions where their  
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5 106 at-risk status is high[13, 14]. Over the last decade, there has been an approximate 70% reduction of  
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7 107 schistosomiasis prevalence amongst school-aged children by 2019[11]. However, due to existing  
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9 108 policy gaps and program intervention bottlenecks, some of the adolescent at-risk populations do not  
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11 109 always benefit from praziquantel treatment[15] and in respect of FGS, many girls and women are  
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13 110 missed out in treatment campaigns and not provided with adequate individualized treatments.

14  
15 111 To address this treatment deficit, with better knowledge on the precise associations between UGS and  
16  
17 112 FGS, future control policies and intervention campaigns can be revised to better target at-risk  
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19 113 populations. For example, this could be upon future activation of integrated primary health care for  
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21 114 better management of FGS, which is currently lacking. Understanding the risks and associations of  
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23 115 these UGS and FGS, especially within different contexts of women's health, sheds greater light on the  
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25 116 disease epidemiology, which could foster improved control measures both locally and nationally.  
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27 117 Furthermore, precisely documenting existing associations between both FGS and UGS clarifies  
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29 118 further the strong need for precision mapping of schistosomiasis in endemic regions, for formulating a  
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31 119 better targeted integrated response.

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34 120 In our study, we sought to clarify existing associations between FGS and UGS, highlighting cardinal  
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36 121 symptomologies for scalable detection and targeted control of FGS within UGS endemic areas. This  
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38 122 supports the need for a future integrated approach for control of schistosomiasis, and limits the “gap”  
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40 123 concerning FGS surveillance within current primary care.

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## 44 125 **Materials and Methods**

### 45 126 **Ethics approval and consent to participate**

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48 127 Ethical clearance for the study was provided by the Cameroon National Ethics committee on Human  
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50 128 Health Research (Ref N ° 2020/07/1266/CE/CNERSH/SP), with administrative authorizations from  
51  
52 129 both from the Regional Delegation of Public Health for the West region of Cameroon (Ref N°  
53  
54 130 679/L/MINSANTE/SG/DRSPO/CBF), the district Health Office of the Malanteoun Health District  
55  
56 131 (Ref N° 078/L/MINSANTE/DRSPO/DSMLT). Informed written and oral consent was obtained from  
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3 132 all participants for parasitological and gynecological examinations. For participants <18 years, parents,  
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5 133 husbands, or guardian gave informed permission and assent was obtained from the participants.  
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7 134 Privacy and confidentiality of medical information were protected during and after the study.  
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### 10 135 **Patient and Public Involvement**

11  
12 136 We followed national guidelines to get overall patient and public involvement guidance, and tailored  
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14 137 visits for data collection according to best practice and local engagement. Written assent of  
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16 138 participants was gotten in their homes.  
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### 19 139 **Study Setting**

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21  
22 140 This study was carried out across a sub-group of girls and women residing in remote fishing  
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24 141 communities in the Matta Health Area in the West Region of Cameroon, around the Mape Dam, a  
25  
26 142 known transmission focus for *Schistosoma haematobium*[11, 16]. Apart from reporting symptoms for  
27  
28 143 UGS such as blood in urine, for FGS specifically included vaginal itch and smelly discharge, lower  
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30 144 abdominal pain, painful coitus, missed periods and miscarriages[17]. As previously detailed, all study  
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32 145 participants were involved actively in fishing or other household activity that put them in constant  
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34 146 contact with the lake water,[17]. Of note, the Matta Health Area hosts several remote fishing island  
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36 147 communities that surround the man-made barrage (Mape Dam), and for at least 18 years has  
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38 148 witnessed high transmission of *S. haematobium* with prevalence of UGS in children greater than  
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40 149 50%[18].  
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### 44 150 **Study Design and Procedures**

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47 151 This observational cross-sectional survey was conducted between the periods of December 2020 to  
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49 152 June 2021. The total population estimate of the study site was 5,000 people[19], where women  
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51 153 represented 51.0% of the population, with the age group 15-64 years representing 54.6% of the total  
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53 154 population. Using a simple random sampling technique, on the base of attaining a precision rate of  
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55 155 95% with an error margin of 5%, our initial sample size was estimated statistically using the  
56  
57 156 population proportion formula  $n = N * X / (X + N - 1)$ , where,  $X = Z_{\alpha/2} * \sqrt{p * (1-p)} / MOE^2$ , and  $Z_{\alpha/2}$   
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59 157 is the critical value of the normal distribution at  $\alpha/2$  (for the confidence level of 95%,  $\alpha$  is 0.05 and the  
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3 158 critical value is 1.96), MOE is the margin of error (5%), p is the sample proportion (55%), and N is the  
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5 159 population size (1400), giving a required sample size of 387. This was later attained with a 85%  
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7 160 success rate[17] due to logistic and cultural limits. Of the 304 participants originally sampled and  
8  
9 161 tested for UGS, a sub-group of 67 women and girls from an unbiased selection with explicit inclusion  
10  
11 162 and exclusion criteria underwent clinical gynecological examination (for FGS) by colposcopy with  
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13 163 photo documentation. For this sub-group an exclusion criteria of: age (>13 years), virginity status (not  
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15 164 virgin), menstruation (not in current menses), and pregnancy (not pregnant), was applied alongside  
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17 165 obtaining consent for gynecological exam (Fig 1), by a trained gynecologist with previous experience  
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19 166 in diagnosing FGS.  
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25 168 **Figure 1: Study participant selection criteria and numbers with diagnostic methods flow**  
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30 170 A structured questionnaire (see Supplementary File 1) with FGS related symptoms, sexual and  
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32 171 reproductive health, and socio-demographic questions was administered privately in a one-to-one  
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34 172 format. On average interviews were completed during 35 minutes and were conducted after the urine  
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36 173 was collected from each study participant. Each participant responded to the structured questionnaire  
37  
38 174 and was prompted to discuss further on related symptoms if they wished to share, but these were not  
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40 175 formally registered by the questionnaire.  
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44 176 Participants were selected for gynecological examination based on having a UGS urine test performed  
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46 177 and having a completed response to questionnaire concerning FGS symptoms and water contact  
47  
48 178 activity. Sexual and reproductive health questions included : sexual activeness, age at marriage, number  
49  
50 179 of children, age of last child, any miscarriage, menstrual irregularities or abnormalities. Demographic  
51  
52 180 questions asked included: age, level of formal or informal schooling achieved, water contact activities,  
53  
54 181 and income generating activities. Most females encountered were married by age14, which helped  
55  
56 182 guide the minimum age band set for the study. To better explore age-related profiles, three age sub-  
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58 183 groups were formed: adolescence (14-19), young adults (20-35) and older adults (36+).  
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60

## 184 **Parasitological and Gynecological Examinations**

185 At least 10 ml of urine was collected and analyzed by visual inspection for macrohaematuria and then  
186 tested for microhaematuria and proteinuria with reagent strips (Siemens Multistix 10 SG) at the local  
187 health center laboratory on the same day of collection. Urine syringe filtration technique was  
188 performed with visualization of schistosome eggs by x100 using a light compound and stained with  
189 Lugol's iodine. A sample was deemed positive for *S. haematobium* if at least one terminal-spined  
190 ovum was seen, and the number of ova reported as per  $\geq 50$  (high intensity) or  $< 50$  (low intensity).  
191 Next, consenting eligible girls and women were examined by clinical colposcopy with photo-  
192 documentation, using a hand held colposcope (EVA COLPO, Mobile ODT). The obtained images  
193 were cross-checked against the WHO FGS pocket atlas[20] to record key sequelae. These were then  
194 saved in a coded database, accessible to predetermined independent experts. An FGS positive case was  
195 declared upon the presence of either sandy patches, abnormal blood vessels and sandy patches on  
196 homogenous yellow areas in line with the WHO FGS pocket atlas coding[20].

## 197 **Statistical Analysis**

198 All numerical data on girls and women examined for FGS ( $n = 67$ ) were extracted from the main  
199 database in Excel and imported into the R (version 4.0.2) software for statistical analyses. In univariate  
200 analysis, frequencies and proportions were reported for socio-demographic characteristics. In bivariate  
201 analysis, Pearson's chi-squared tests were used to test the dependence of reproductive health  
202 related independent variables against FGS or UGS (dependent variables). To further explain such  
203 dependence, univariate logistic regression analyses was used, with the results presented in the form of  
204 unadjusted odds ratios. To identify amongst the reproductive health related independent variables  
205 associated to UGS and FGS, multivariate logistic regressions analyses were used, with the results  
206 presented in the form of adjusted odds ratios (AOR), alongside 95% confidence intervals (CI) and  $p$ -  
207 values based on the Wald's Test. To fit the models, only factors significantly related to the outcomes  
208 at a 25% level of significance in the univariate models were included. Multicollinearity between  
209 independent variables was tested using the variance inflation factor. The forward-backward stepwise  
210 selection method was used to obtain the "best" fitting models. Analysis of deviance tables

211 accompanied by likelihood ratio tests were used to assess the global significance of the different  
 212 variables in the final statistical models. In all, the level of significance was set at  $p < 0.05$ .

213

## 214 **Results**

### 215 i. **Demographic Characteristics of Participants**

216 Analysis was restricted to the 67 post-menarche sexually active girls and women above the age of 13  
 217 who gave informed consent for and participated in full for all aspects of the study. Participants were  
 218 classified into 3 age-groups: adolescents (14 -19 years); young adults (20-35 years); and older adults  
 219 (36+ years). Table 1 presents a summary of the socio-demographic characteristics (age-group,  
 220 residence, marital status and water contact history) of the study participants. The median age was 21  
 221 years; interquartile range [IQR] 18–25, where adolescents represented 28.4% of the study participants,  
 222 young adults 43.3%, and older adults 28.4%.

223 **Table 1: Participant Characteristics**

224 <b>Socio-demographical characteristics</b>		
225	<b>N</b>	<b>Proportion</b>
225 <b>Age group (N= 67)</b>		
226 14-19	19	28.4%
227 20-35	29	43.3%
228 36+	19	28.4%
229 <b>Economic activity (N= 67)</b>		
230 Fishing	31	46.4%
231 Farming	03	4.5%
232 Fishing/Farming	33	49.3%
233 <b>Proximity to lake (N= 67)</b>		
< 200m	07	89.6%
≥200m	60	10.4%
234 <b>Marital status (N= 67)</b>		
235 Married	66	98.5%
236 Widowed	1	1.5%

231 None of the 67 participants had completed primary level of education (formal education), all had  
 232 completed a cultural training (informal education) considered as a requisite for socialization and  
 233 marriage. Over 98% of participants were currently married, about 35% by the age of 14, and the

234 remainder after the age of 15. The main occupations were fishing and farming (49.3%), fishing  
235 (46.3%), and farming only (4.5%).

236 Of the total number of participants (n=67), 40 were confirmed to have ova-patent UGS, and 34 for  
237 FGS upon the presence of homogenous yellow sandy patches, grainy sandy patches and abnormal  
238 blood vessels. One participant was noted to have rubbery papules, a condition previously thought to be  
239 restricted to Madagascar, and is the first time this condition has been reported in Cameroon (Fig 2).

240

241 **Figure 2 : Imagery of FGS pathology of the cervix with reported lesions (magnification of x4)**

242 **A)** 1-rubbery papule, 2-abnormal blood vessel, 3- homogeneous sandy patch (30 year old woman, +UGS,  
243 +lower abdominal pain, +Menstrual irregularity) ; **B)** 1,2- grainy sandy patches (45 year old woman, -UGS,  
244 +lower abdominal pain ; +Menstrual irregularity)

245

246 **ii. UGS, FGS and associations with reproductive health characteristics**

247 Age, number of children, age of last child, menstrual abnormality, miscarriages, and lower abdominal  
248 pain were identified as possible reproductive health factors associated with *S. haematobium* infection,  
249 and were used within this study. Table 2 presents UGS, FGS and their relationship with these  
250 reproductive health characteristics, based on chi-square tests of independence on one hand, and  
251 univariate logistic regression on the other. Generally, both FGS and UGS were not significantly ( $P$ -  
252 value  $>0.05$ ) related to number of children, age of last child and miscarriages. However, a significant  
253 relationship between FGS and age group ( $P=0.009$   $X^2$  test) and menstrual abnormality ( $P=0.005$   $X^2$   
254 test) was observed, while both FGS ( $P=0.001$   $X^2$  test) and UGS ( $P=0.023$   $X^2$  test) were observed to be  
255 significantly associated with lower abdominal pain. In effect, the probability of infection with FGS  
256 was seen to increase with age, with unadjusted odds ratios (UOR) of 6.4 (95% C: I 1.6-30.4) for older  
257 adults, 6.1 (95% CI: 1.7-26.1) for young adults, relative to adolescents as reference category. On the  
258 other hand, a non-significant decrease in chances of infection with urogenital schistosomiasis was

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3 259 observed with increasing age. Furthermore, the chances of FGS infection amongst girls with menstrual  
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5 260 abnormality (collected as irregular, painful or ceased menstruation), was UOR 7.1(95% CI: 2.5-22.1)  
6  
7 261 times that for girls without the abnormality. Chances of FGS infection amongst women with lower  
8  
9 262 abdominal pain, was 17.1 (95% CI: 4.2-117.1) times that of women without lower abdominal pain. A  
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11 263 similar trend was observed with UGS, but on a lower scale [UOR 4.3 (95% CI: 1.4-14.4)].  
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14 264 Additionally, a non-statistically significant increase in prevalence of menstrual abnormalities was  
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16 265 observed with increasing age ( $X^2=1.51$ ,  $df=2$ ,  $p\text{-value}=0.469$ ). In effect, the prevalence of menstrual  
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18 266 abnormalities amongst adolescents was 44.4%, young adults 48.3%, and older adults 63.2%.  
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**Table 2:** Associations of certain sexual and reproductive health characteristics between UGS and FGS: Univariate logistic regression model on the effects of UGS and FGS on sexual and reproductive health factors and on the probability of contracting FGS after UGS

SRH Indicator	Category	FGS					N	UGS				
		Chi2 Test of Independence			Univariate logistic regression			Chi2 Test of Independence			Univariate logistic regression	
		FGS + n(%)	FGS - n(%)	P value	Unadjusted OR (95% C.I.)	P value		UGS + n(%)	UGS - n(%)	P value	Unadjusted OR (95% C.I.)	P value
Age group	13-19	4 (11.8)	15 (45.5)	<b>0.009</b>	1.0		19	13 (32.5)	6 (22.2)	<b>0.439</b>	1.0	
	20-35	18 (52.9)	11 (33.3)		6.1 (1.7, 26.1)	0.008	29	18(45)	11(40.7)		0.8 (0.2, 2.5)	0.653
	36+	12 (35.3)	7 (21.2)		6.4 (1.6, 30.4)	0.012	19	9(22.5)	10(37)		0.4 (0.1, 1.5)	0.192
Number of Children	None	4 (11.8)	9 (30)	<b>0.107</b>	1.0		13	9(24.3)	4(14.8)	<b>0.185</b>	1.0	
	1-3	10 (29.4)	12 (40)		1.8 0.5, 8.7)	0.394	22	12(32.4)	10(37)		0.5 (0.1, 2.)	0.394
	4-6	11 (32.4)	4 (13.3)		6.2 (1.3, 36.1)	0.030	15	11(29.7)	4(14.8)		1.2 (0.2, 6.6)	0.811
	7+	9 (26.5)	5 (16.7)		4.1 (0.9, 22.3)	0.088	14	5(13.5)	9(33.3)		0.3 (0.0, 1.2)	0.088
Age of last child	1-3	13(46.4)	15(71.4)	<b>0.115</b>	1.0		28	14(53.8)	14(60.9)	<b>0.188</b>	1.0	
	4-6	4(14.3)	0(0)		Inf	0.993	4	4(15.4)	0(0)		Inf	0.993
	7+	11(39.3)	6(28.6)		2.1 (0.6, 7.7)	0.237	17	8(30.8)	9(39.1)		0.9 (0.3, 2.9)	0.848
Menstrual abnormality	No	9(26.5)	23(71.9)	<b>0.005</b>	1.0		32	17(43.6)	15(55.6)	<b>0.453</b>	1.0	
	Yes	25(73.5)	9(28.1)		7.1 (2.5, 22.1)	<0.001	34	22(56.4)	12(44.4)		1.6 (0.6, 4.4)	0.340
Miscarriages	0	8(23.5)	15(50)	<b>0.104</b>	1.0		23	11(29.7)	12(44.4)	<b>0.211</b>	1.0	
	1	14(41.2)	8(26.7)		3.3(1.0, 11.7)	0.057	22	16(43.2)	6(22.2)		2.9(0.9, 10.7)	0.093
	2+	12(35.3)	7(23.3)		3.2(0.9, 11.9)	0.071	19	10(27)	9(33.3)		1.2 (0.4, 4.2 )	0.757
Lower abdominal pain	No	2(5.9)	16(51.6)	<b>0.001</b>	1.0		18	6(15.8)	12(44.4)	<b>0.023</b>	1.0	
	Yes	32(94.1)	15(48.6)		17.1 (4.2, 117.1)	0.001	47	32(84.2)	15(55.6)		4.3(1.4, 14.4)	0.014
Parasitaemia (egg density)	0	10(29.4)	17(51.5)	<b>0.172</b>	1.0		27					
	1-49	15(44.1)	9(27.3)		2.8 (0.9, 9.2)	0.073	24					
	50+	9(26.5)	7(21.2)		2.2 (0.6, 7.9)	0.224	16					

269 \*Inf signifies very large odds ratio

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271 **iii. Multivariate Logistic Regression Model for Reporting Reproductive Health Risk**  
 272 **Factors**

273 Multicollinearity was observed between age group, number of children and age of last child, and so we  
 274 resorted to excluding number of children and age of last child in the multivariate model. Multivariate  
 275 logistic regression analyses results for identifying associates amongst reproductive health  
 276 characteristics to both FGS and UGS infections are given in Table 3. After selection of the best fitting  
 277 models, the results show that the only significant risk factor for UGS is lower abdominal pain, whereas  
 278 age-group and lower abdominal pain were identified as the two main significant risk factors for FGS.  
 279 In the same line as with the Univariate regression results in Table 2, the probability of infection with  
 280 female genital schistosomiasis was seen to increase with age, with adjusted odds ratios (AOR) of 7.7  
 281 (95% CI: 1.4-55.7) for older adults, 5.9 (95% CI: 1.3-34.3) for young adults, relative to adolescents as  
 282 reference category. Chances of FGS infection amongst women with lower abdominal pain was AOR  
 283 9.5(95% CI:1.7-81.8) times that of women without the pain. Analysis of deviance tables for both best  
 284 fitting models (FGS and UGS), with *p*-values based on likelihood ratio tests are reported in Table 4.

285 **Table 3:** Key risk factors amongst SRH between UGS and FGS. A multivariate logistic regression  
 286 model on the effects of UGS and FGS on sexual and reproductive health factors and on the probability  
 287 of contracting FGS after UGS.

SRH Indicator	Category	FGS		UGS	
		Multivariate Logistic Regression		Multivariate Logistic Regression	
		Adjusted OR (95% C.I.)	P value	Adjusted OR (95% C.I.)	P value
Age group	14-19	1.0		//	
	20-35	5.9 (1.3, 34.3)	0.032	//	//
	36+	7.7 (1.4, 55.7)	0.027	//	//
Menstrual abnormality	No	1.0		//	
	Yes	3.9 (1.0, 16.7)	0.056	//	//
Lower abdominal pain	No	1.0		1.0	
	Yes	9.5 (1.7, 81.8)	0.017	4.3 (1.4, 14.4)	0.014

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289 // signifies that variable was not considered in the best fitting model

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291 **Table 4:** Analysis of deviance tables showing the global significance of the different variables in the  
 292 best fitting models.

Variable	Df	Deviance	Resid. df	Resid. Dev	P-value
<b>1. FGS</b>					
Age-group	2	7.916	62	82.050	0.019
Menstrual abnormality	1	14.024	61	68.031	<0.001
Lower abdominal pain	1	7.010	60	61.021	0.008
<b>2. UGS</b>					
Lower abdominal pain	1	5.846	61	80.201	0.016

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## 295 Discussion

296 Our study, given our application of portable colposcopy, is the first formal attempt to document the  
 297 pathology of FGS in a primary care setting in Cameroon. Elsewhere, the clinical pathology of FGS has  
 298 been described resulting from the complex inflammatory responses to antigens released by adult  
 299 worms and viable eggs, which persists until some time after adult worms are stopped egg-laying or are  
 300 destroyed by praziquantel[21]. Thereafter, various signs and symptoms may present months or even  
 301 years after treatment[22]. Though a non-significant association ( $P=0.172$ ) was observed between egg  
 302 intensity in urine and FGS from the onset of this study (Table 2), parasitaemia association has been  
 303 shown to be misleading from several other studies and reports on FGS, particularly when only a single  
 304 urine sample is examined which is usually the case for population-based surveillance[3]. The  
 305 possibility of the presence of FGS in UGS populations has been often raised[6, 23], with projections of  
 306 about 360 million girls and women possibly infected with UGS but today it is thought that at least 56  
 307 million adolescent girls and women are suffering from FGS[24, 25]. Our results maybe show an even  
 308 higher rate of FGS infection amongst the UGS infected population with an approximate FGS/UGS  
 309 ratio of 34/40.

310 From present results, and within the general literature[24, 25], one of such effects noted is an effect on  
 311 menstrual health. More than half of women within the study who reported poor menstrual health (FGS  
 312 = 73.5% ; UGS = 54.6%), either as irregular, painful or seized menstruation, were found to either shed  
 313 eggs in urine (positive for UGS), or were positive for FGS, but without eggs in urine. A significant  
 314 trend was seen with more women positive for FGS reporting abnormal menstruation, than for UGS.

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3 315 This confirms recent analysis suggests strong linkages between menstrual health management and  
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5 316 FGS[24], an under researched area. In our study post-menarche females already faced a substantial  
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7 317 challenge with limited access to hygienic material and information on menstrual health management,  
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9 318 typically relying on self made clothes and absorbent plant leaves during menstruation, due to lack of  
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11 319 finances or general knowledge. Also an increase (though non-significant) in menstrual abnormality  
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13 320 was recorded with increasing age-group, where older adults (36+) experienced more abnormalities  
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15 321 than the younger women who in-turn observed higher abnormalities than adolescents. This can be  
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17 322 credited to the fact that symptoms perhaps diminished after a while with UGS (maybe as a result of  
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19 323 treatment in mass drug administration campaigns), but later resurface with more chronic sequelae of  
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21 324 FGS, and with more dire symptoms and negative impact on mental health[24].  
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25 325 To affirm this, narratives from a previous study which used qualitative probing showed women  
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27 326 infected with FGS and not shedding eggs in urine, gave a history of having lived in their earlier years  
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29 327 in heavily infested *S.haematobium* foci, which explained their later manifestation of FGS symptoms,  
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31 328 even after having moved away to a less infested area, with more than 90% limit in fresh water  
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33 329 contact[17]. The significant difference in menstrual abnormalities amongst UGS positive women  
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35 330 [n=22(56.4)] and UGS negative women [n=12 (44.4)], alerts to future chronicity of FGS after  
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37 331 infection with UGS, especially if not managed with praziquantel treatment(s). This implies the need  
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39 332 for early management with more readily available praziquantel treatment for UGS to avoid future risks  
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41 333 of FGS[22, 26].  
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44 334 On its own, lower abdominal pain observed significant association (in adjusted and unadjusted  
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46 335 regression models) in both UGS and FGS infections. The chances of having lower abdominal pain  
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48 336 was significantly higher in females with either FGS (94.1%) or UGS (84.2%). This reported as key  
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50 337 indicator for UGS and FGS, directing early diagnosis of UGS and future FGS in endemic  
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52 338 communities, promoting the verticalization of control strategies for both diseases.  
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54  
55 339 Another trend observed in this study is that intensity of infection or egg patent-prevalence (for UGS)  
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57 340 reduces while chronic disease or morbidity for FGS increases as women age. Since women aged  
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59 341 (36+), chances of infection with FGS after infection with UGS increased significantly (AOR 6.43,95%

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3 342 C.I 1.62-30.35, P=0.0091), similarly reported in other studies in different geographical locations[3, 27-  
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5 343 29] and recently in this area[17]. This diverts once small from the two most common hypothesis of age  
6  
7 344 and infection for *S.haematobium* infection[30]; emphasizing on the level of present intensity of  
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9 345 infection for UGS, and possible future occurrence of FGS[28, 29].This age-infection association in  
10  
11 346 both UGS and FGS, is highlighted further in the Multivariate model here, where emphasise on  
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13 347 infection history for UGS and FGS is seen more clearly. UGS at a younger age will in some cases  
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15 348 manifest into FGS when the female is older, causing more intense gynecological symptoms and  
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17 349 effects. This offers a possible guiding tool for better control policies, related to early diagnosis and  
18  
19 350 treatment[31, 32]. This surpasses need alone for school-based MDAs, but considers and encourages  
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21 351 individual therapy in different contexts for FGS (and MGS)[3]. Also, these results support the  
22  
23 352 advocated need for availability of praziquantel in lowest level (health areas and community) Health  
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25 353 Centers for individual therapy[29], as well as treatment from a younger age[25, 26, 32, 33] buoyed  
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27 354 with the recent development of pediatric praziquantel[34].  
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31 355 Although only a few amongst the extensive list of reproductive health determinants were identified in  
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33 356 this study to be statistically significant, where mostly reported symptoms were collected, clinical and  
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35 357 biological examinations carried out, enabled confirmation of how future self-reported symptoms with  
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37 358 UGS and FGS might be best used[17].  
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## 43 360 **Conclusion**

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46 361 In our chosen study location, which is broadly typical for endemic areas of UGS in Cameroon, strong  
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48 362 epidemiological associations between UGS and FGS were found against certain key sexual and  
49  
50 363 reproductive determinants: age, lower abdominal pain and menstrual health. This formative  
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52 364 knowledge could be utilised to tackle and ultimately prevent FGS, with a more targeted integrated  
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54 365 control for UGS in Cameroon and elsewhere in endemics areas for UGS in sub-Saharan Africa.  
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3 368 **Supporting Files**  
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5 369 Supplementary File 1.docx : Structured questionnaire  
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10 371 **Declarations**

11  
12 372 • **Authors' contributions**  
13  
14

15 373 MCM and JRS conceptualized the study and planned the methodology; VAG, MCM, NTM, carried  
16  
17 374 out field investigation; MCM, FNB, JRS, ASO analysed and interpreted the data for this manuscript;  
18  
19 375 MCM acquired funding for study and wrote the original draft of the manuscript; JRS supervised the  
20  
21 376 study and was a major contributor in the conceptualization and writing of the manuscript; FNB, VG,  
22  
23 377 NTM, ASO, reviewed and edited the manuscript. All authors approved the final version of the paper  
24  
25 378 before submission.  
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28  
29 379 • **Competing interests**  
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32 380 The authors declare that they have no competing interests.  
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48 387 collection and analysis, decision to publish, or preparation of the manuscript.  
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55 389 All data generated or analyzed during this study are included in this published article [and its  
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57 390 supplementary files].  
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54 414 • **Consent for publication**  
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56  
57 415 Written informed consent for publication of clinical details and/or clinical images was obtained from  
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59 416 the patients and parents/guardians where needed.  
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28 509 • **Figure Legends**

29  
30 510 **Figure 1:** Study participant selection criteria and numbers with diagnostic methods flow

31  
32 511 **Figure 2 :** Imagery of FGS pathology of the cervix with reported lesions (magnification of x4)

33  
34 512 **A)** 1-rubbery papule, 2-abnormal blood vessel, 3- homogeneous sandy patch (30 year old woman, +UGS,  
35 513 +lower abdominal pain, +Menstrual irregularity) ; **B)** 1,2- grainy sandy patches (45 year old woman, -UGS,  
36 514 +lower abdominal pain ; +Menstrual irregularity)  
37

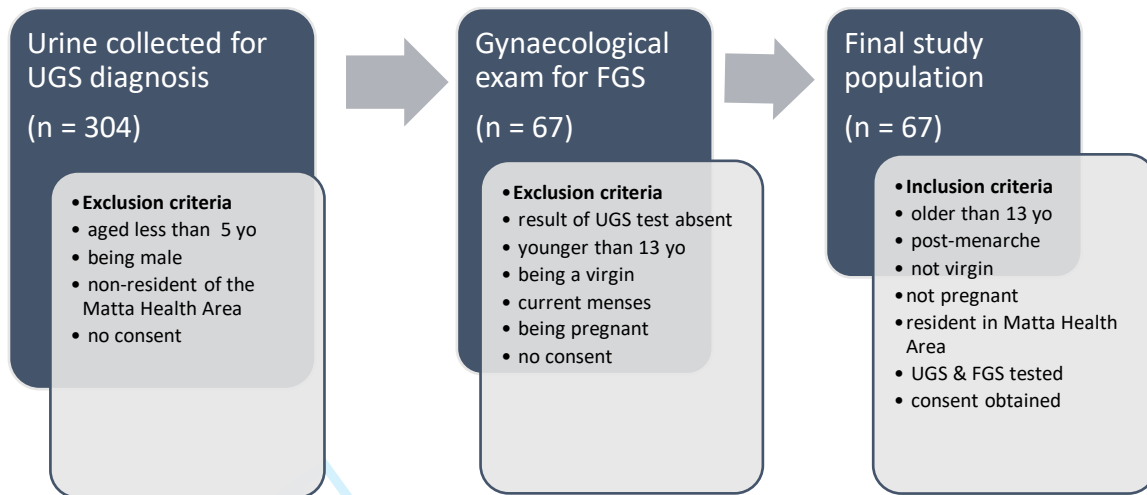
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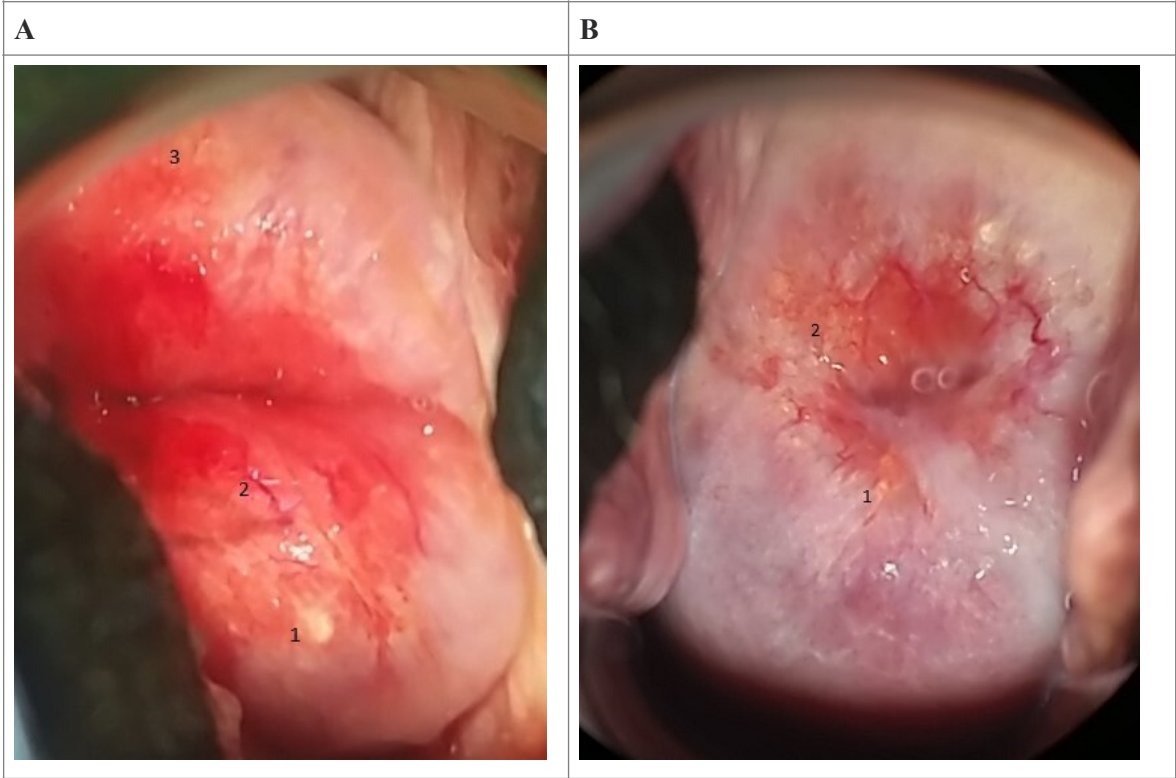
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## Supplementary File 1

Close-ended structured questionnaire**A. Close ended structured questionnaire– Administered directly in English with oral translations into Fulbe, Kotoko, Mosgum, and Arab**

Name of Community: \_\_\_\_\_

Age (years): \_\_\_\_\_

Education: Informal education ( ) Formal education ( ) (specify) \_\_\_\_\_

Marital Status: Single ( ) Married ( ) Separated ( ) Widowed ( )

No of years having lived in community \_\_\_\_\_

Previous community \_\_\_\_\_

Economic activity-----

Residence ----- (collect coordinates)

**Questions on symptoms of urinary tract schistosomiasis; FGS; OR STI**

1. Do you see your menses? Yes ( ) No ( )
2. Did you observe/experience your menses within the last two weeks? Yes ( ) No ( ) Does your menses come every month? Regular?
3. Is your menses painful? \_\_\_\_\_(pain during menstruation – always very painful, sometimes painful, normal) Irregular? \_\_\_\_\_(every month?, not every month, stopped)
4. Do you have pain in your lower abdomen? When? For how long?
5. Do you have pain when urinating? Yes ( ) No ( )
6. Do you have difficulty in urinating (urine not coming out fluently)? Yes ( ) No ( )
7. Do you have sudden uncontrollable and unexpected urge to urinate and mostly cannot hold it? Even when you cough it comes out? Yes ( ) No ( )
8. Do you see blood in your urine? Yes ( ) No ( )
9. (If yes) When did you lastly see blood in your urine? \_\_\_\_\_Always, sometimes, Once in a while
10. Do you sometimes haveitching in your private part?Yes ( ) No ( )
11. How often do you experience this? Once a while ( ) frequently ( )/ When was the last time?
12. Do you have a feeling of burning within your private part? Yes ( ) No ( )

1  
2  
3 13. How often do you experience this? Once a while ( ) Frequently ( )  
4

5 14. Do you sense a swelling/lumps within your private part? Yes ( ) No ( ) No response ( )  
6

7 15. Do you have any discharge that comes from your vagina? Yes ( ) No ( ) Does it have an odour?  
8

9 \_\_\_\_\_ Do you see the colour? Yes ( ) No ( ) What Color is it? White; grey; green/yellow;  
10

11 brown  
12

13 16. Do you think this is normal? Yes ( ) No ( ) Do not know ( ). When did you start observing the  
14 discharge? Date \_\_\_\_\_  
15

16 17. After sexual intercourse do you have a discharge? Yes ( ) No ( ) Is it smelly? Yes ( ) No ( ) Do not  
17 know ( )  
18

19 18. After or during sexual intercourse do you have pain? Yes ( ) No ( ) I do not know ( ) ; Do  
20 you have a bloody discharge? Yes ( ) No ( ) I do not know ( )  
21

22 19. Have you had any miscarriages /pregnancies that passed? Yes ( ) No ( )  
23

24 20. How many? ( )  
25

26 21. Do you have children? Yes ( ) No ( )  
27

28 22. What age is your last child? ( )  
29

30 23. Have you visited the clinic to complain about these issues? Yes ( ) No ( )  
31

32 24. What you used/taken/done to treat any of these problems? \_\_\_\_\_ (Underline) Hospital  
33 or drug store/ local midwife/ traditional medicine/ prayers/ none of the above (what other?  
34 Specify)/nothing  
35  
36

### 37 **Water contact History**

38 1. Where do you fetch your household water? Lake; other source (name) \_\_\_\_\_  
39

40 2. Do you fish in the lake? Yes ( ), No ( )  
41

42 3. Do you bathe in the lake? Yes ( ), No ( )  
43

44 4. What do you use the lake for? ( ) \_\_\_\_\_  
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# BMJ Open

## Urogenital Schistosomiasis (UGS) and Female Genital Schistosomiasis (FGS) in Cameroon: An observational assessment of key reproductive health determinants of girls and women in the Matta Health Area

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<b>Primary Subject Heading</b>:	Public health
Secondary Subject Heading:	Infectious diseases, Epidemiology
Keywords:	Epidemiology < TROPICAL MEDICINE, PARASITOLOGY, Colposcopy < GYNAECOLOGY, Infection control < INFECTIOUS DISEASES

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2  
3 1 **Title:** Urogenital Schistosomiasis (UGS) and Female Genital Schistosomiasis (FGS) in Cameroon: An  
4 2 observational assessment of key reproductive health determinants of girls and women in the Matta  
5 3 Health Area  
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1  
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3 26 **Abstract**  
4

5 27 **Objectives and Setting:** Across sub-Saharan Africa, Urogenital Schistosomiasis (UGS), in particular  
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7 28 Female Genital Schistosomiasis (FGS) is a significant waterborne parasitic disease, with its direct  
8  
9 29 burden upon the sexual and reproductive health (SRH) of sufferers infrequently measured. UGS has an  
10  
11 30 established control plan, which in most endemic regions as in Cameroon, still excludes FGS  
12  
13 31 considerations. Highlighting existent associations between UGS and FGS could increase the  
14  
15 32 management of FGS within UGS interventions. This study seeks to identify current associations  
16  
17 33 amongst FGS and UGS with some reproductive health indicators, to provide formative information for  
18  
19 34 better integrated control.  
20  
21  
22

23 35 **Participants:** 304 females aged 5- 69 years, were all examined for UGS by urine filtration and  
24  
25 36 microscopy. Amongst these, 192 women and girls were eligible for FGS assessment based on age (>13).  
26  
27 37 After questioning for FGS symptoms, a sub-group of 67 women and girls from this population consented  
28  
29 38 for clinical assessment for FGS through application of portable colposcopy, with observed sequelae  
30  
31 39 classified according to the WHO FGS pocket atlas.  
32  
33

34 40 **Outcome:** Overall UGS and FGS prevalence was measured, with FGS/UGS related reproductive health  
35  
36 41 symptoms recorded. Epidemiological associations with FGS and UGS were investigated by univariate  
37  
38 42 and multivariate logistic regression analyses.  
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40

41 43 **Results:** Overall UGS prevalence was 63.8% (194/304), where FGS prevalence (sub group) was 50.7%  
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43 44 (34/67). FGS increased significantly with increasing age, whilst a non-significant decrease with  
44  
45 45 descending age was observed for UGS. Lower abdominal pain (LAP) vaginal itches (VI), and coital  
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47 46 pain (CP), were identified as the main significant shared symptoms of both FGS and UGS, while LAP  
48  
49 47 with MI appeared a strong epidemiological flag for FGS.  
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51

52 48 **Conclusion:** LAP, MI, CP and VI provide under-explored dimensions in SRH that could be exploited  
53  
54 49 in future for targeting of praziquantel provision to FGS sufferers within primary care, complementary  
55  
56 50 with existing distribution for UGS sufferers in *S. haematobium* endemic areas.  
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3 51 **Keywords:** *Schistosoma haematobium*, SRH, clinical colposcopy, questionnaires, menstrual health,  
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5 52 abdominal pain  
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10  
11 54 **Strengths and Limitations of this study**  
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13 55 - Using clinical colposcopy, a not very common tool within primary health care settings in sub-Saharan  
14 56 Africa, combined with an analysis of sexual and reproductive health determinants, we identify existing  
15 57 relationships with symptoms of FGS and UGS affecting the sexual and reproductive health of women  
16 58 in sub-Saharan Africa, which could inform the development of a simple questionnaire approach to better  
17 59 capture FGS sufferers within endemic areas for UGS.  
20

21  
22 60 - Here, formative evidence is provided with initial recommendations, towards developing better  
23 61 national surveillance and control of FGS, thereby better empowering women's health within low  
24 62 resource settings, especially where schistosomiasis is endemic.  
25  
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28 63 - This study did not consider clinical diagnosis of girls younger than 14, especially as non-invasive  
29 64 clinical diagnostic tools are lacking for examination amongst this age group within low resource  
30 65 schistosomiasis endemic communities.  
31  
32

33 66 - Assessment for STIs amongst participants are not presented here, where such results could complement  
34 67 or clarify FGS diagnosis, considering most sexual and reproductive health related symptoms for  
35 68 urogenital schistosomiasis present as sexually transmitted infections, and can be misdiagnosed.  
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55 77 **Introduction**  
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57 78 In endemic areas, a definitive diagnosis of Urogenital schistosomiasis (UGS) is established by  
58 79 demonstration of viable *Schistosoma (S) haematobium* eggs ( $\geq 1$ ) in urine and/haematuria[1, 2], whilst

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3 80 female genital schistosomiasis (FGS) can be diagnosed visually for *S. haematobium* induced cervical  
4  
5 81 lesions and small fibrotic nodules known as “sandy patches”[2, 3], either with the presence or absence  
6  
7 82 of *S. haematobium* eggs in urine[1, 4, 5]. Whilst both FGS and UGS are caused by infection with  
8  
9 83 *Schistosoma haematobium*[1, 6-8] a waterborne blood fluke, each appear to have some unclear  
10  
11 84 epidemiological associations, largely due to insufficient disease surveillance[4, 5, 9, 10]. In sub-Saharan  
12  
13 85 Africa where UGS is endemic and can be highly prevalent (>50%)[11, 12], insufficient or infrequent  
14  
15 86 efforts have been undertaken to document FGS specifically[10, 13-15], partly as the clinical skills to do  
16  
17 87 so are lacking and uninformed within primary care[9]. While active UGS does not readily predict  
18  
19 88 FGS[4], since FGS can occur without the direct presence of schistosome eggs in urine (a cardinal  
20  
21 89 diagnostic for UGS)[15, 16], rather FGS often presents with a more chronic time frame where  
22  
23 90 schistosome eggs are trapped within the cervico-vaginal surfaces[4, 17, 18]. For some, these trapped  
24  
25 91 eggs can accumulate from very early on in life[7], with enduring and typically hidden sequelae[17, 19].  
26  
27 92 Based on several biological determinants such as age[7], the mucosal damage and fibrotic scarring of  
28  
29 93 the vaginal and cervical surfaces from FGS proceeds with increasing duration of UGS infection(s)[4];  
30  
31 94 moreover, FGS-specific sequelae maybe slow to resolve upon standard antiparasitic treatment of  
32  
33 95 UGS[20, 21], i.e., single annual administration of praziquantel at 40mg/g as used in public health  
34  
35 96 campaigns[4, 17].  
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40  
41 97 In many parts of Africa where surveillance of UGS is limited[22] and that for FGS largely absent[12,  
42  
43 98 23], there is a clear need to better understand the epidemiological associations between UGS and  
44  
45 99 FGS[11]. Particularly so, to support earlier diagnosis of cases of FGS, and individualize praziquantel  
46  
47 100 treatment needs (for individual and context specific case management)[12, 24] to better avert their  
48  
49 101 disease progression[12]; as current interventions against UGS do not specifically target adolescent girls  
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51 102 or women[20, 25]. This gap in treatment coverage[24] also has considerable bearing on progress towards  
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53 103 elimination of schistosomiasis transmission within disease endemic communities[25].  
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58 104 In recent years, FGS focused research and public health education[26] has gained traction in certain  
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60 105 countries such as Ghana, Tanzania, Madagascar and Mozambique[6, 8], although other countries such

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3 106 as Cameroon, currently lag behind[27, 28] Schistosomiasis exists in several regions of Cameroon[29],  
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5 107 affecting over 10 million people in rural and urban areas[30]. The country has a national coordinated  
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7 108 control plan for fairly early interventions during child-hood years (from 5 – 14 years old)[31], which  
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9  
10 109 take advantage of school based intervention platforms[32, 33], and in certain settings, with community  
11  
12 110 based interventions, where their at-risk status (people or communities dependent on Schistosomiasis  
13  
14 111 endemic water bodies, for main water source) is high[18, 27, 31, 34, 35]. Even with improved (>70%)  
15  
16 112 helminth control amongst children in the last decade [30], some of the adolescent at-risk populations  
17  
18 113 do not always benefit from praziquantel treatment due to existing policy gaps and program intervention  
19  
20 114 challenges [[12, 36, 37].

21  
22  
23 115 To address this treatment deficit, capture missed opportunities, and ensure the consideration and  
24  
25 116 apprehension of ensuing FGS manifestations within such already identified sub-groups (young girls  
26  
27 117 and women); with better knowledge on the precise associations between UGS and FGS, future control  
28  
29 118 policies and intervention campaigns can be revised to better target at-risk populations.

30  
31 119 Here, we sought to clarify existing associations between FGS and UGS, highlighting cardinal  
32  
33 120 symptomologies for scalable detection and targeted control of FGS within UGS endemic areas. This  
34  
35 121 supports the need for a future integrated approach for control of Schistosomiasis and limits the “gap”  
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37 122 concerning FGS surveillance within current primary care.

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## 51 52 129 **Materials and Methods**

### 53 54 55 130 **Ethics approval and consent to participate**

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58 131 Ethical clearance for this study was provided by the Cameroon National Ethics committee on Human  
59  
60 132 Health Research (Ref N ° 2020/07/1266/CE/CNERSH/SP), with administrative authorizations from

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2  
3 133 both the Regional Delegation of Public Health for the West region of Cameroon (Ref N°  
4  
5 134 679/L/MINSANTE/SG/DRSPO/CBF), and the district Health Office of the Malanteoun Health District  
6  
7 135 (Ref N° 078/L/MINSANTE/DRSPO/DSMLT). Informed written and oral consent was obtained from  
8  
9 136 all participants for parasitological and gynecological examinations. For participants <18 years, parents,  
10  
11 137 husbands, or guardian gave informed permission and assent was obtained from the participants. Privacy  
12  
13 138 and confidentiality of medical information were protected during and after the study.

### 16 139 **Patient and Public Involvement**

19 140 We followed inclusive and participative methods to get overall participant and public involvement,  
20  
21 141 where tailored visits for data collection were carried out according to best practices with local  
22  
23 142 engagement of key community members and local health workers.

### 26 143 **Study Setting**

29 144 This study was carried out across a group of girls and women residing in remote communities in the  
30  
31 145 Matta Health Area in the West Region of Cameroon, around the Mape Dam, a known transmission focus  
32  
33 146 for *Schistosoma haematobium*[30, 35]. Most study participants were involved actively in fishing or  
34  
35 147 other household activity that put them in constant contact with the lake water[28]. More than 90% of  
36  
37 148 the population lived less than 200m to an endemic water source (the Mape Dam) and more than 75%  
38  
39 149 depended fully on the Mape Dam for house-hold water and for an income generating activity (fishing)  
40  
41 150 [28, 35]. Of note, the Matta Health Area hosts several remote fishing island communities that surround  
42  
43 151 the man-made barrage (Mape Dam), and for at least 18 years has witnessed high transmission of *S.*  
44  
45 152 *haematobium* with prevalence of UGS in children greater than 50%[38].

### 49 153 **Study Design and Procedures**

51 154 This cross-sectional study was conducted between the periods of December 2020 to June 2021. The total  
52  
53 155 population estimate of the study site was 5,000 people[39], where women represented 51.0% of the  
54  
55 156 population, with the age group 15-64 years representing 54.6% of the total population. With no existing  
56  
57 157 records of schistosomiasis prevalence amongst adults within the Matta Health area, a hypothesis of UGS  
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59 158 endemicity amongst adults was based on recorded school-age Schistosomiasis prevalence (> 41% in the

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2  
3 159 last decade) and within the Matta health Area [35, 38, 40]. Based on lake proximity and economic  
4  
5 160 activity, 11 main communities were visited within the Matta Health Area: nine secluded water-locked  
6  
7 161 fishing communities (Islands/fishing camps) with habitations mostly less than 200m from the lake; and  
8  
9 162 two mainland communities (land-locked) with habitation more than 400m from the lake[28]. Following  
10  
11 163 a simple random sampling technique, on the base of attaining a precision rate of 95% with an error  
12  
13 164 margin of 5%, our initial sample size was estimated statistically using the population proportion  
14  
15 165 formula[41] $n = N * X / (X + N - 1)$ , where,  $X = Z_{\alpha/2} \sqrt{p * (1-p) / MOE^2}$ , and  $Z_{\alpha/2}$  is the critical value  
16  
17 166 of the normal distribution at  $\alpha/2$  (for confidence level of 95%,  $\alpha$  is 0.05 and critical value is 1.96), MOE  
18  
19 167 is the margin of error (5%),  $p$  is the sample proportion (55%), and  $N$  is the population size (1400)[28].  
20  
21  
22 168 The Finite Population Correction has been applied to the sample size formula.  
23  
24  
25 169 Thus,  $n = 1400 * 3.8 / (3.8 + 1400 - 1)$ , with  $n = 387$ . With an originally determined sample size of 387,  
26  
27 170 due to logistic and cultural constraints, 304 (78.55%) of target recruitment was reached [28]. Due to the  
28  
29 171 secluded nature of study communities (far from health care setting), and the preference of a participative  
30  
31 172 nature for recruiting (involvement of formal/informal health workers and some community members),  
32  
33 173 recruitment was contextualized within each community as per the propositions of key community  
34  
35 174 members (including participants themselves). Of the 304 participants sampled and tested for UGS, 193  
36  
37 175 girls and women were eligible for FGS assessment (Figure 1). Eligibility criteria for clinical FGS  
38  
39 176 diagnosis consisted: >13, non-virgin, not menstruating, not pregnant, and consent/assent from parent or  
40  
41 177 spouse for girls younger than 18. Based on eligibility criteria, participant availability, and logistics  
42  
43 178 constraints, a final sub-group of 67 women and girls were assessed clinically for FGS (Figure 1). Thus,  
44  
45 179 within this sub-group, after questioning (questionnaire), consenting participants underwent  
46  
47 180 gynecological examination by colposcopy with photo documentation by a trained gynecologist and  
48  
49 181 midwife, with previous experience in diagnosing FGS. All participants were recruited and screened  
50  
51 182 within the community, mostly in their homes or a 'safe' house prescribed by the women themselves, or  
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53 183 the village leader.  
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185 **Figure 1: Study participant selection criteria and numbers with diagnostic methods flow**

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187 After UGS assessment, for girls and women older than 13, a structured questionnaire (see  
188 Supplementary File 1) with FGS related symptoms[28], sexual and reproductive health, and socio-  
189 demographic questions, was administered privately in a one-to-one format. On average interviews were  
190 completed during 35 minutes and were conducted after the urine was collected from each study  
191 participant. Participants responded to the structured questionnaire and were prompted to discuss further  
192 on related symptoms if they wished to share.

193 Sexual and reproductive health related questions included: sexual activeness, (with age of first encounter  
194 or age at marriage), number of children, age of last child, any miscarriage, menstrual irregularities or  
195 abnormalities, abdominal pain, coital pain, and vaginal itches with abnormal discharges. Demographic  
196 questions asked included: age, level of formal or informal schooling achieved, water contact activities,  
197 and income generating activities. Most females encountered were married by age14, which helped guide  
198 the minimum age for the study, in terms of in deciphering a general baseline for assessing girls for FGS  
199 (through general sexual health related questions, and invasive gynecological examination) for FGS.  
200 Also, age at marriage was used to determine/suggest sub-fertility amongst participants as the age of first  
201 child, last child and presence or absence of children was deciphered from the number of years in  
202 marriage (or being sexually active)[28, 42]. To better explore age-related profiles, three age groups were  
203 formed around these context specific sexual and reproductive health characteristics: adolescence (14-  
204 19), young adults (20-35) and older adults (36+).

205

### 206 **Parasitological and Gynecological Examinations**

207 Dipstick diagnosis of microscopic haematuria[43], and urine syringe filtration technique with  
208 microscopic-based poly-carbonate filter examination for urinary eggs, were used on a single urine  
209 sample for standard UGS detection within this study. At least 10 ml of urine was collected and observed  
210 for macrohaematuria, tested for microhaematuria and proteinuria with reagent strips (Siemens Multistix

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3 211 10 SG), then analyzed for *S. haematobium* eggs, at the local health center laboratory on the same day of  
4  
5 212 collection. Microscopy for visualization of schistosome eggs was performed by x100 using a light  
6  
7 213 compound and stained with Lugol's iodine. A urine sample was deemed positive for UGS on the  
8  
9 214 presence of haematuria[44] with at least one terminal-spined ovum seen[45], and the number of ova  
10  
11 215 reported as per  $\geq 50$  (high intensity) or  $< 50$  (low intensity)[46]. Next, consenting eligible girls and  
12  
13 216 women were examined by clinical colposcopy with photo-documentation, using a hand held colposcope  
14  
15 217 (EVA COLPO, Mobile ODT). The obtained images were cross-checked against the WHO FGS pocket  
16  
17 218 atlas[2] to record key sequelae. These were then saved in a coded database for the internal validation  
18  
19 219 through blinded evaluation of cervical images from photo-colposcopy by external team members, after  
20  
21 220 the cross examination with the WHO Pocket atlas. A minimal clinical indication for FGS was  
22  
23 221 determined upon the presence of sandy patches, abnormal blood vessels and/or sandy patches on  
24  
25 222 homogenous yellow areas, in line with the WHO FGS pocket atlas coding[2] after cross verification by  
26  
27 223 external team members  
28  
29  
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31 224 .  
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33

### 34 225 **Statistical Analysis**

35  
36 226 All numerical data on females examined were extracted from the main database in Excel, and imported  
37  
38 227 into the R (version 4.0.2) software for statistical analyses. In univariate analysis, frequencies and  
39  
40 228 proportions were reported for socio-demographic, syndromic and clinical variables. In bivariate  
41  
42 229 analysis, Pearson's chi-squared tests were used to test the dependence of socio-demographic, clinical  
43  
44 230 and syndromic reproductive health related independent variables against the dependent variables FGS  
45  
46 231 and UGS. To further highlight such dependence, univariate logistic regression analyses was used, with  
47  
48 232 the results presented in the form of unadjusted odds ratios. To identify most relevant variables amongst  
49  
50 233 the reproductive health related independent variables associated to each of UGS and FGS, multivariate  
51  
52 234 logistic regressions analyses were used, with the results presented in the form of adjusted odds ratios  
53  
54 235 (AOR), alongside 95% confidence intervals (CI) and *p*-values based on the Wald's Test. To fit the  
55  
56 236 models, only factors significantly related to the outcomes at a 25% level of significance in the univariate  
57  
58 237 models were included. Multicollinearity between independent variables in the initial multivariate  
59  
60



238 models were evaluated using the `vif` function in the `car` R package and our knowledge on how the  
239 variables were measured. The `step` function in the R package `stats` was applied to the resulting  
240 multivariate models after correcting for multicollinearity to select the “best” fitting model. The global  
241 significance of variables in the final models were evaluated based on analysis of deviance tables using  
242 the `anova` function in the `stats` R package. In all, the level of significance was set at  $p$ -value  $<0.05$ .

243

## 244 Results

### 245 A. General participant characteristics

246 A total sample population of 304 females were met, aged from 5 to 69 years old (192 of reproductive  
247 age,  $>13$  and  $<70$ , with mean $\pm$ SD age of  $28 \pm 12.7$ ). Also, 88.16% of participants were dependent  
248 on, and lived within a proximity of  $\leq 200$ m to the Mape lake (Island communities), and the remaining  
249 11.82% came from Mainland communities, which were further from the lake ( $>400$ m), having  
250 alternative water sources (wells and stand taps), and involved in farming alone without fishing activities.  
251 Furthermore, 28.29% showed proteinuria, and a 50.0% prevalence (152) was recorded for  
252 microhematuria, with a specificity and sensitivity of 74.5% (95% CI: 67.1 – 80.8) and 74.8% (95% CI:  
253 67.4 – 81.1) respectively. The Geometric Mean Egg (GME) count was 33.1 (Range: 2 – 1220) among  
254 which 36.2% had heavy ( $\geq 50$  eggs/10ml of urine) infection while 63.8% had light ( $> 50$  eggs/10ml of  
255 urine) infection. Macrohematuria was strongly related to egg density categories ( $\chi^2 = 17.7$ ;  $P < 0.001$ ),  
256 where cases of macrohematuria were directly related to heavy egg load (93.2%). Information related  
257 to sub fertility/infertility was captured based on age at marriage, number of children and the age of last  
258 child, with more than half of the study population reporting not having received treatment with  
259 praziquantel in more than a year (see Table 1). Reported sexual and reproductive health syndromes  
260 showed lower miscarriages (58.89%), abdominal pain (56.95%), lower back pain (44.59%), coital pain  
261 (45.98%), coital bleeding (37.93), vaginal itches (68%), abnormal vaginal discharge (42.6%) and  
262 menstrual irregularities (47.74%) to be comparatively higher amongst participants, compared to and  
263 stress incontinence (19.47) (see Table 1).

264 Table 1: General characteristics of all study participants (Sociodemographic, syndromic, clinical)

Variable	Category	Number of Women	Percentage
<b>1. Demographic</b>			
Age (groups)	0 <14	111	36.51
	1[14-19]	62	20.39
	2[20-35]	83	27.3
	36+	48	15.79
Age at marriage	13-15	71	39.89
	15-17	88	49.44
	18+	19	10.67
No of Children	0	44	24.31
	1[1-3]	72	39.78
	2[4-6]	37	20.44
	7+	28	15.47
Age of last child	0+	10	7.69
	1[1-3]	67	51.54
	2[4-6]	15	11.54
	7+	38	29.23
Treatment with praziquantel	< 12 months	1	0.3
	> 12 months	292	96.1
	Never	11	3.6
Economic Activity	Fishing (with/without farming)	211	87.5
	Farming (without fishing)	30	12.4
Proximity to lake	<200m	268	88.16
	>400m	36	11.84
<b>2. Syndromic</b>			
Lower Abdominal Pain	Yes	127	56.95
Coital Pain	Yes	80	45.98
Coital bleeding	Yes	66	37.93
Vaginal Itches	Yes	153	68
Vaginal Discharge	Yes	90	42.06
External genital Itch	Yes	86	41.75
Lower back Pain	Yes	99	44.59
Stress Incontinence	Yes	44	19.47
Menstrual Irregularities	Yes	95	47.74
Fertility	Sub fertility (marriage age + youngest child= 4+)	158	88.8%
	Infertility (marriage age + no of children=o)	20	11.2%
Miscarriages	0	74	41.11
	1+	106	58.89
<b>3. Clinical</b>			
Parasitemia	0	141	46.38
	1[1-50]	104	34.21
	50+	59	19.41
Hematuria	+	19	6.25
Microhaematuria	+	152	50
Proteinuria	+	86	28.29

### 1. UGS Characteristics amongst sample population

Table 2 presents the relationship between UGS as a dependent factor and each of the sociodemographic and reported reproductive health characteristics based on chi-square tests of independence and univariate logistic regression. The results indicate that the chances of UGS infection amongst women who lived more than 400m from the lake was 0.36 (95% CI: 0.17-0.72) times that of women who lived less than

272 200m to the lake, implying that significant odds of being infected with UGS was seen with closer lake  
 273 proximity. A significant decrease in chances of infection with urogenital schistosomiasis was observed  
 274 with increasing age. Relative to girls <14 years, girls between 14-19 years had a 0.46 (95% CI: 0.22-  
 275 0.95) odds of having UGS, as opposed to 0.29 (95% CI: 0.15-0.54) odds for adults ranging from 20-35  
 276 years, and 0.09 (95% CI: 0.04-0.19) odds for women older than 35 years. All reported reproductive  
 277 health syndromes showed significant relationship with UGS infection, except for stress incontinence  
 278 (UOR 1.72 [95% CI: 0.87-3.54]  $p=0.1287$ ). In effect, women with lower abdominal pain, coital pain,  
 279 vaginal itch, menstrual irregularity, and coital bleeding showed significantly higher odds (Table 2) of  
 280 infection with UGS.

281 **Table 2:** Relations between UGS and each socio-demographic and syndromic variable in the study  
 282 sample

Variables	Category	N	Chi2 Test of Independence			Univariate logistic regression	
			UGS – n (%)	UGS + n (%)	P-value	Unadjusted OR (95% C.I.)	P value
Age group	<14	111	20 (18.2)	91 (46.9)	0	1	0.0352
	[14-19]	62	20 (18.2)	42 (21.6)		0.46 (0.22, 0.95)	
	[20-35]	83	36 (32.7)	47 (24.2)		0.29 (0.15, 0.54)	
	36+	48	34 (30.9)	14 (7.2)		0.09 (0.04, 0.19)	
No of Children	0	44	15 (18.1)	29 (29.6)	0.0462	1	0.2143
	[1-3]	72	33 (39.8)	39 (39.8)		0.61 (0.28, 1.32)	
	[4-6]	37	16 (19.3)	21 (21.4)		0.68 (0.27, 1.67)	
	7+	28	19 (22.9)	9 (9.2)		0.25 (0.09, 0.66)	
Age of Last Child	0+	10	4 (6)	6 (9.5)	0.0323	1	0.5863
	[1-3]	67	33 (49.3)	34 (54)		0.69 (0.16, 2.62)	
	[4-6]	15	4 (6)	11 (17.5)		1.83 (0.33, 10.6)	
	7+	38	26 (38.8)	12 (19)		0.31 (0.07, 1.27)	
Miscarriages	0	74	41 (48.8)	33 (34.4)	0.1055	1	0.0382
	1	52	19 (22.6)	33 (34.4)		2.16 (1.05, 4.52)	
	2+	54	24 (28.6)	30 (31.2)		1.55 (0.77, 3.17)	
Lower Abdominal Pain	Yes	127	42 (45.2)	85 (65.4)	0.0039	2.29 (1.33, 3.98)	0.0028
Coital Pain	Yes	80	25 (30.5)	55 (59.8)	0.0001	3.39 (1.82, 6.43)	0.0001
Coital bleeding	Yes	66	19 (23.2)	47 (51.1)	0.0002	3.46 (1.82, 6.79)	0.0002
Vaginal Itches	Yes	153	51 (53.7)	102 (78.5)	0.0001	3.14 (1.77, 5.67)	0.0001
Abnormal Vaginal Discharge	Yes	90	27 (29)	63 (52.1)	0.0008	2.66 (1.51, 4.76)	0.0008
Lower Back Pain	Yes	99	34 (36.6)	65 (50.4)	0.0551	1.76 (1.03, 3.06)	0.0416
Stress Incontinence	Yes	44	14 (14.7)	30 (22.9)	0.1729	1.72 (0.87, 3.54)	0.1287
Genital Itches	Yes	86	26 (28.6)	60 (52.2)	0.0007	2.73 (1.53, 4.94)	0.0008
Menstrual Irregularity	Yes	95	29 (33)	66 (59.5)	0.0002	2.98 (1.68, 5.4)	0.0002
Proximity to lake	<20m	268	89 (80.9)	179 (92.3)	0.0051	1	0.0042
	>200m	36	21 (19.1)	15 (7.7)		0.36 (0.17, 0.72)	

283

## 284 **Multivariate Logistic Regression Model for Reporting Sexual and Reproductive Health (SRH)**

### 285 **Risk Factors related to UGS**

286 After including all variables significantly related to UGS at a 25% level in a multivariate model,  
 287 multicollinearity issues were suspected between lower abdominal pain and lower back pain; and external

288 genital itch and vaginal itches. However, considering genital itch responses were most often related to  
 289 vaginal itch or misreported by respondents due to their literal similarity in Pidgin English or Fulbe used  
 290 during questioning, we resorted to keeping only Vaginal Itches in the model. Similarly for lower back  
 291 pain and lower abdominal pain because of the similarity in responses, but with a more comprehensive  
 292 responding for lower abdominal pain, lower back pain was removed. The resulting “best” fitting model  
 293 included Age group, Lower abdominal pain and coital pain as the most significant sexual and  
 294 reproductive health risk factors for UGS (Table 3). In this result, we also observed a decreasing trend in  
 295 UGS infection with increasing age. Also, the odds of infection in women with lower abdominal pain  
 296 was 6.42 (95% CI: 2.85 - 15.68) times that for women without the pain. The odds of infection in women  
 297 with coital pain was 2.16 (95% CI: 1.05 – 4.46) times that for women without the pain.

298  
 299 **Table 3:** Possible risk factors for UGS amongst the socio-demographic and SRH included in the study.  
 300 A multivariate logistic regression model on the effects of sexual and reproductive health factors  
 301 significantly related to UGS infection.

SRH Indicator	Category	Adjusted OR (95% C.I.)	P value
Age group	[14-19]	1.0	
	20-35]	0.28 (0.10, 0.70)	0.0087
	36+	0.11 (0.04, 0.31)	0.0001
Lower Abdominal Pain	No	1.0	
	Yes	6.42 (2.85, 15.68)	0.0000
Coital Pain	No	1.0	
	Yes	2.16 (1.05, 4.46)	0.0362

302

## 303 2. FGS Characteristics amongst study participants (Sub group)

304 Of the total number of participants examined for FGS after UGS ( $n=67$ ), 40 were confirmed to have  
 305 ova-patent UGS, and 34, for FGS upon the presence of homogenous yellow sandy patches, grainy sandy  
 306 patches, and abnormal blood vessels (Figure 2). Related reproductive health syndromes (as reported in  
 307 UGS), similarly, were all found to have some association ( $P < 0.05$ ) with FGS manifestation amongst  
 308 females (Table 4), except for stress incontinence. Of import amongst these, menstrual irregularities or  
 309 abnormality (collected as irregular, painful or ceased menstruation), more so than found with UGS, was  
 310 seen to have 7.9 times higher odds of affecting women with FGS than women without FGS (Table 4).

311 Contrarily to UGS, back pain was seen to significantly affect women with FGS manifestations than was  
 312 the case with UGS. Similarly, odds of having FGS manifestations were seen to descend with age (Table  
 313 4), unlike UGS which was significant with ascending age. Lower abdominal pain, menstrual irregularity  
 314 and lower back pain showed the highest odds of manifesting amongst women positive for FGS.

315 **Figure 2: Imagery of FGS pathology of the cervix with reported lesions (magnification of x4)**

316 **A)** 1-rubbery papule, 2-abnormal blood vessel, 3- homogeneous sandy patch (30 year old woman,  
 317 +UGS, +lower abdominal pain, +Menstrual irregularity) ; **B)** 1,2- grainy sandy patches (45 year old  
 318 woman, -UGS, +lower abdominal pain ; +Menstrual irregularity)

320 **Table 4: Relations between FGS and socio-demographic and syndromic variables in the sub group of**  
 321 girls and women diagnosed for FGS

Variable	Category	N	Chi2 Test of Independence			Univariate logistic regression				
			FGS – n(%)	FGS + n(%)	P-value	Unadjusted OR (95% C.I.)		P value		
Age group	[14-19]	19	15 (45.5)	4 (11.8)	0.0091	1	(1.73, 26.1)	0.0077		
	[20-35]	29	11 (33.3)	18 (52.9)		6.14				
	36+	19	7 (21.2)	12 (35.3)		6.43			(1.62, 30.35)	0.0116
Age at Marriage	13-15	23	10 (30.3)	13 (38.2)	0.1286	1	(0.19, 1.58)	0.2765		
	15-17	38	22 (66.7)	16 (47.1)		0.56				
	18+	6	1 (3)	5 (14.7)		3.85			(0.51, 79.99)	0.2510
No of Children	0	16	12 (36.4)	4 (11.8)	0.0363	1	(1.19, 28.98)	0.0357		
	[1-3]	22	12 (36.4)	10 (29.4)		2.5			(0.64, 11.23)	0.2024
	[4-6]	15	4 (12.1)	11 (32.4)		8.25			(1.79, 46.95)	0.0102
	7+	14	5 (15.2)	9 (26.5)		5.4				
Age of Last Child	0+	1	1 (4.8)	0 (0)	0.1199	1	(0, Inf)	0.9965		
	[1-3]	27	14 (66.7)	13 (46.4)		Inf				
	[4-6]	4	0 (0)	4 (14.3)		Inf			(0, Inf)	0.9937
	7+	17	6 (28.6)	11 (39.3)		Inf			(0, Inf)	0.9963
Miscarriages	0	26	18 (54.5)	8 (23.5)	0.0362	1	(1.14, 14.19)	0.0343		
	1	22	8 (24.2)	14 (41.2)		3.94			(1.22, 13.78)	0.0256
	2+	19	7 (21.2)	12 (35.3)		3.86				
Lower Abdominal Pain	Yes	47	15 (45.5)	32 (94.1)	0	19.2	(4.74, 131.08)	0.0003		
Coital Pain	Yes	32	10 (30.3)	22 (64.7)	0.0071	4.22	(1.55, 12.16)	0.0058		
Coital bleeding	Yes	29	8 (24.2)	21 (61.8)	0.0029	5.05	(1.82, 15.19)	0.0026		
Vaginal Itches	Yes	49	18 (54.5)	31 (91.2)	0.0009	8.61	(2.44, 40.95)	0.0021		
Vaginal Discharge	Yes	32	9 (27.3)	23 (67.6)	0.0014	5.58	(2.01, 16.67)	0.0013		
Back Pain	Yes	41	12 (36.4)	29 (85.3)	0	10.15	(3.31, 36.45)	0.0001		
Stress	Yes	10	0 (0)	10 (29.4)	0.0009	Inf	(0, Inf)	0.9927		
Incontinence										
Genital Itch	Yes	32	9 (27.3)	23 (67.6)	0.0014	5.58	(2.01, 16.67)	0.0013		

Menstrual irregularities	Yes	34	9 (27.3)	25 (73.5)	0.0002	7.41	(2.61, 23)	0.0003
Proximity	<20m	60	30 (90.9)	30 (88.2)	1	1		
	>200m	7	3 (9.1)	4 (11.8)	1	1.33	(0.27, 7.25)	0.7212

322

### 323 **Multivariate Logistic Regression Model for Reporting Sexual and Reproductive Health (SRH)** 324 **Risk Factors related to FGS**

325 Similar to UGS, a multivariate model was constructed with all variables significantly related to FGS at  
326 a 25% level. As well, multicollinearity checks revealed lower back pain and genital itch (for same  
327 reasons) with the variables age group, coital pain, vaginal itches and lower abdominal pain (Table 5)  
328 retained in the “best” fitting model.

329

330 **Table 5:** Possible risk factors amongst SRH for FGS. A multivariate logistic regression model on the  
331 effects of FGS infection on sexual and reproductive health factors.

SRH Indicator	Category	Adjusted OR (95% C.I.)	P value
Age group	[14-19]		
	[20-35]	20.15 (2.92, 240.94)	0.0061
	36+	41.29 (4.16, 946.69)	0.0054
Coital Pain	No	1.0	
	Yes	10.44 (2.12, 90.91)	0.0105
Vaginal Itches	No	1.0	
	Yes	12.50 (1.92, 128.77)	0.0151
Lower Abdominal Pain	No	1.0	
	Yes	28.80 (3.36, 578.24)	0.0081

332

### 333 **3. UGS, FGS and associations with reproductive health characteristics**

334 Age, number of children, age of last child, menstrual abnormality, miscarriages, and lower abdominal  
335 pain were identified as possible reproductive health factors associated with *S. haematobium* infection,  
336 and were used within this study. Generally, both FGS and UGS were not significantly ( $P$ -value  $>0.05$ )  
337 related to number of children, age of last child and miscarriages. In multivariate logistic regression  
338 models, after selection of the best fitting models, the results show that the most significant risk factors  
339 for UGS are age group, lower abdominal pain and coital pain (Table 4), whereas age-group and lower  
340 abdominal pain, coital pain and vaginal itches were identified as the most significant risk factors for  
341 FGS (Table 5). Chances of FGS manifestations amongst women with lower abdominal pain was AOR  
342 9.5(95% CI:1.7-81.8) times that of women without the pain (Table 5). Analysis of deviance tables for

343 both best fitting models (FGS and UGS), with *p*-values based on likelihood ratio tests are reported in  
344 Supplementary File 2.

345

## 346 **Discussion**

347 Our study, given our application of portable colposcopy, is the first formal attempt to document the  
348 pathology of FGS in a primary care setting in Cameroon. Elsewhere, the clinical pathology of FGS has  
349 been described resulting from the complex inflammatory responses to antigens released by adult worms  
350 and viable eggs[4, 11], which persists until sometime after adult worms are stopped egg-laying or are  
351 destroyed by praziquantel[21]. Thereafter, various signs and symptoms may present months or even  
352 years after treatment[20, 37]. Understanding the risks and associations of these UGS and FGS, especially  
353 within different contexts of women's health[36, 47], sheds greater light on the disease epidemiology,  
354 which could foster improved and coordinated control measures both locally and nationally[36].  
355 Furthermore, precisely documenting existing associations between both FGS and UGS could clarify  
356 further the need for precision mapping of schistosomiasis in endemic regions, for formulating a better  
357 targeted integrated response[43]. Though a non-significant association was observed between egg  
358 intensity in urine and FGS from the onset of this study (Table 2), parasitemia association has been  
359 shown to be misleading[5] from several other studies and reports on FGS, particularly when only a  
360 single urine sample is examined which is usually the case for population-based surveillance[4].  
361 Considering this, questionnaire (for symptoms)[9, 18], as well as visual examination of cervix and  
362 vaginal walls by colposcopy[15, 48], offers an added strength to single sample urinalysis for detection  
363 of FGS, as carried out in this study, and several others[9, 15]. The possibility of the presence of FGS in  
364 UGS populations has been often raised[6, 18], with projections of about 360 million girls and women  
365 possibly infected with UGS[12], but today it is thought that at least 56 million adolescent girls and  
366 women are suffering from FGS[12, 14]. Our results maybe show an even higher rate of FGS infection  
367 amongst the UGS infected population with an approximate FGS/UGS ratio of 34/40.

1  
2  
3 368 From present results, and within the general literature[12, 14], one of such effects noted is an effect on  
4  
5 369 menstrual health. More than half of women within the study who reported poor menstrual health (FGS  
6  
7 370 = 73.5% ; UGS = 54.6%), either as irregular, painful or seized menstruation, were found to either shed  
8  
9 371 eggs in urine (positive for UGS), or were positive for FGS, but without eggs in urine; showing more  
10  
11 372 women positive for FGS reporting abnormal menstruation, than for UGS. This confirms recent  
12  
13 373 analysis[14, 28] and suggests strong linkages between menstrual health management and FGS[12, 14],  
14  
15  
16 374 an under researched area. This can be credited to the fact that symptoms perhaps diminished after a  
17  
18 375 while with UGS (maybe as a result of treatment in mass drug administration campaigns), but later  
19  
20 376 resurface with more chronic sequelae of FGS[14], and with more dire symptoms and negative impact  
21  
22 377 on mental health[14, 28]. In our study context, post-menarche females already faced a substantial  
23  
24 378 challenge with limited access to hygienic material and information on menstrual health management,  
25  
26 379 typically relying on self-made clothes and absorbent plant leaves during menstruation, due to lack of  
27  
28 380 finances or general knowledge.

31  
32 381 Still related to FGS and menstrual health, narratives from a previous study[28] which used qualitative  
33  
34 382 probing showed women having manifestations of FGS and not shedding eggs in urine, gave a history of  
35  
36 383 having lived in their earlier years in heavily infested *S. haematobium* foci, which explained their later  
37  
38 384 manifestation of FGS symptoms, even after having moved away to a less infested area, with more than  
39  
40 385 90% limit in fresh water contact[28]. This as well relates to this study, where compared to UGS, lake  
41  
42 386 proximity was seen to be not very significant to disease manifestation (Table 5), same like egg shedding,  
43  
44 387 still pointing to early-in-life infection and later chronicity. Significant difference in menstrual  
45  
46 388 abnormalities amongst UGS positive women [n=22(56.4)] and UGS negative women [n=12 (44.4)],  
47  
48 389 alerts to future chronicity of FGS after infection with UGS, especially if not managed with more readily  
49  
50 390 available praziquantel treatment(s)[37, 49].

53  
54 391 On its own, lower abdominal pain observed significant association (in adjusted and unadjusted  
55  
56 392 regression models) in both UGS and FGS infections. The chances of having lower abdominal pain was  
57  
58 393 significantly higher in females with either FGS (94.1%) or UGS (84.2%). Similarly with coital pain and  
59  
60 394 vaginal itches, these reported as key indicators for UGS and FGS, directing early diagnosis of UGS and



395 future FGS in endemic communities, promoting the verticalization of control strategies for both  
396 diseases.

397 Another trend observed in this study is that intensity of infection or egg patent-prevalence (for UGS)  
398 reduces while chronic disease or morbidity for FGS increases as women age. Since women aged (36+),  
399 chances of FGS after infection with UGS increased significantly (AOR 6.43,95% C.I 1.62-30.35,  
400 P=0.0091), similarly reported in other studies in different geographical locations[4, 11, 50, 51] and  
401 recently in this area[28]; emphasizing on the level of present intensity of infection for UGS, and possible  
402 future occurrence of FGS[11, 51]. UGS at a younger age will in some cases manifest into FGS when the  
403 female is older[11], causing more intense gynecological symptoms and effects. This offers a possible  
404 guiding tool for better control policies, related to early diagnosis and treatment[36, 52]. This surpasses  
405 need alone for school-based MDAs[24], but considers and encourages individual therapy in different  
406 contexts for FGS (and MGS)[4].

407 Although only a few amongst the extensive list of reproductive health determinants [54] were identified  
408 in this study to be statistically significant, where mostly reported symptoms were collected, clinical and  
409 biological examinations carried out, enabled confirmation of how future self-reported symptoms with  
410 UGS and FGS might be best used[28]. These results support the advocated need for availability of  
411 praziquantel in lowest level (Health Areas and community) of health care for individual therapy[51], as  
412 well as treatment from a younger age[12, 24, 36, 49] buoyed with the recent development of pediatric  
413 praziquantel[53].

#### 414 **Study Limitations**

415 Though described as gold standard[45], active UGS was only detected through observation of eggs in  
416 urine sediments by microscopic-based poly-carbonate filter examination, as well as recommended  
417 dipstick assays for urinary haematuria detection. Alternative molecular assays molecular assays such  
418 as polymerase chain reaction (PCR) for schistosome detection in human serum and urine samples, were  
419 not considered for added sensitivity for UGS and FGS (in vaginal lavage analysis)[54]. Though  
420 recommended[18, 55], only visual examination through inspection for lesions on the cervix, the fornices,

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3 421 and the vaginal walls with a colposcope[2, 48] and screening with questionnaires was considered in the  
4  
5 422 detection of FGS in this study. Lastly, the sample population for FGS detection (n=67) was limited to  
6  
7 423 girls older than age 13, though other reports have shown pre-puberty girls younger than 10 could  
8  
9 424 manifest gynecological damages as a result of infection with urogenital schistosomiasis[11]. In this  
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11 425 study, examination for this group of girls could be limited only to questionnaire, for ethical purposes.  
12  
13

## 14 426 **Conclusion**

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17 427 Whilst millions of women in Cameroon have UGS, its epidemiological connection with FGS is not  
18  
19 428 fully appreciated, which creates an unfortunate knowledge holdup for effective control at the public  
20  
21 429 health level. In our chosen study location, which is broadly typical for endemic areas of UGS in  
22  
23 430 Cameroon[18, 29, 31, 35], strong epidemiological associations between UGS and FGS were found  
24  
25 431 against certain key sexual and reproductive determinants: age, lower abdominal pain and menstrual  
26  
27 432 health. This formative knowledge could be utilized to tackle and ultimately prevent FGS, with a more  
28  
29 433 targeted integrated control for UGS in Cameroon and elsewhere in endemic areas for UGS globally.  
30  
31 434 This study further adds detailed insight into the connection of FGS and UGS within primary care in  
32  
33 435 endemic communities, denoting those with cardinal symptomologies more explicitly for scalable  
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35 436 detection and targeted control of FGS within UGS endemic areas.  
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## 39 438 **Supporting Files**

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42 439 Supplementary File 1.docx : Structured questionnaire

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44 440 Supplementary File 2.docx: Deviance Table  
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47 441

## 48 49 442 **Declarations**

### 50 443 • **Authors' contributions**

51  
52  
53 444 MCM and JRS conceptualized the study and planned the methodology; AEN, VG, MCM, carried out  
54  
55 445 field investigation; MCM, FNB, JRS, ASO, AEN, analyzed and interpreted the data for this manuscript;  
56  
57 446 MCM acquired funding for study and wrote the original draft of the manuscript; JRS supervised the  
58  
59 447 study and was a major contributor in the conceptualization and writing of the manuscript; AEN,  
60

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2  
3 448 coordinated field activities within the Malanteoun Health District; AEN, FNB, VG, ASO, reviewed and  
4  
5 449 edited the manuscript. All authors approved the final version of the paper before submission.  
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12 451 • **Competing interests**

13  
14  
15 452 The authors declare that they have no competing interests.  
16

17  
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31 459 decision to publish, or preparation of the manuscript.  
32

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35 460 • **Data Sharing Statement**

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37  
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40 462 supplementary files].  
41

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57 469 • **License Statement**  
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38 486 • **Consent for publication**

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41 487 Written informed consent for publication of clinical details and/or clinical images was obtained from  
42  
43 488 the patients and parents/guardians where needed.  
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633

### 634 • Figure Legends

635 **Figure 1:** Study participant selection criteria and numbers with diagnostic methods flow

636 **Figure 2:** Imagery of FGS pathology of the cervix with reported lesions (magnification of x4)

637 **A)** 1-rubbery papule, 2-abnormal blood vessel, 3- homogeneous sandy patch (30-year-old woman, +UGS, +lower  
638 abdominal pain, +Menstrual irregularity); **B)** 1,2- grainy sandy patches (45-year-old woman, -UGS, +lower  
639 abdominal pain; +Menstrual irregularity)

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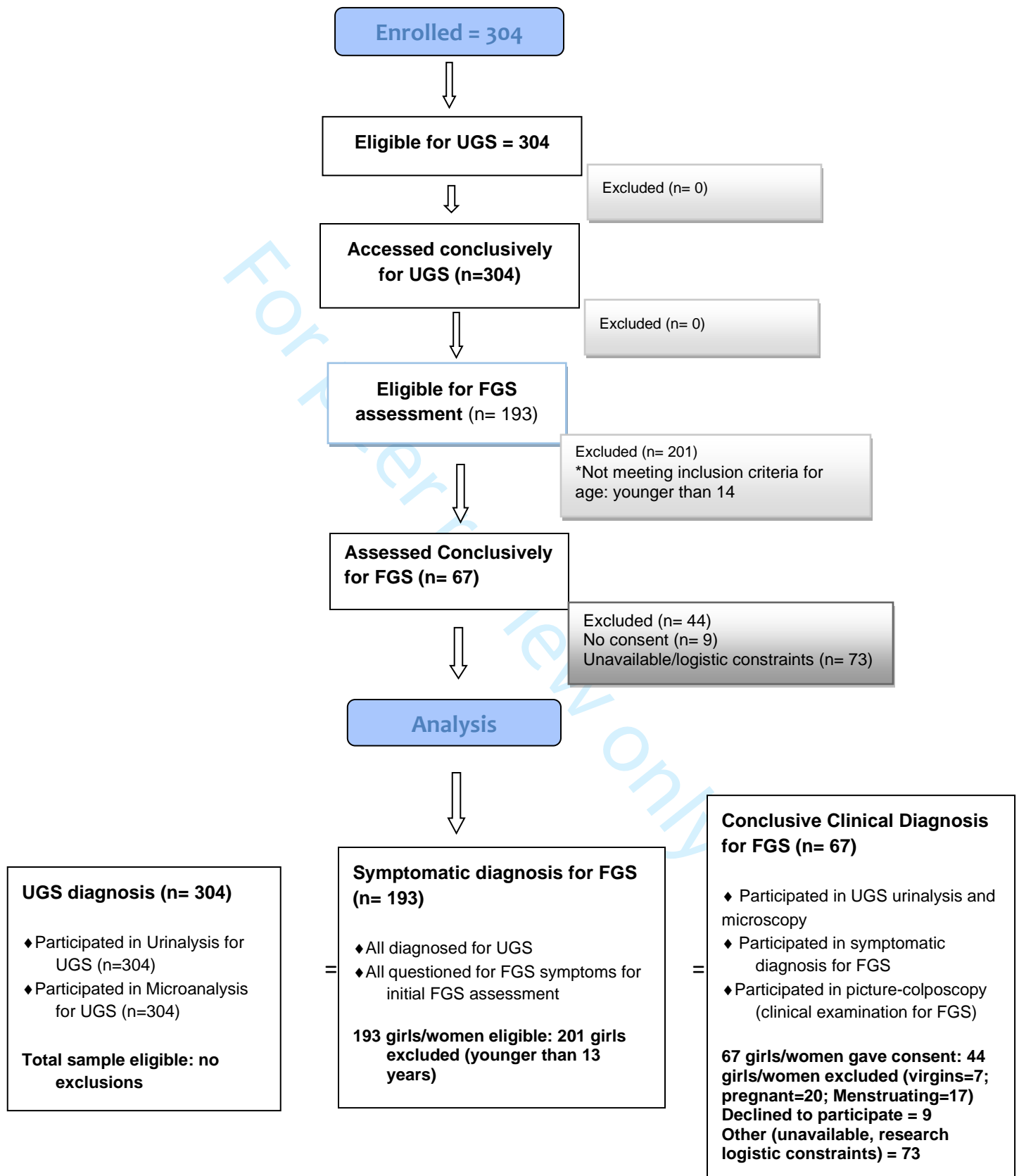
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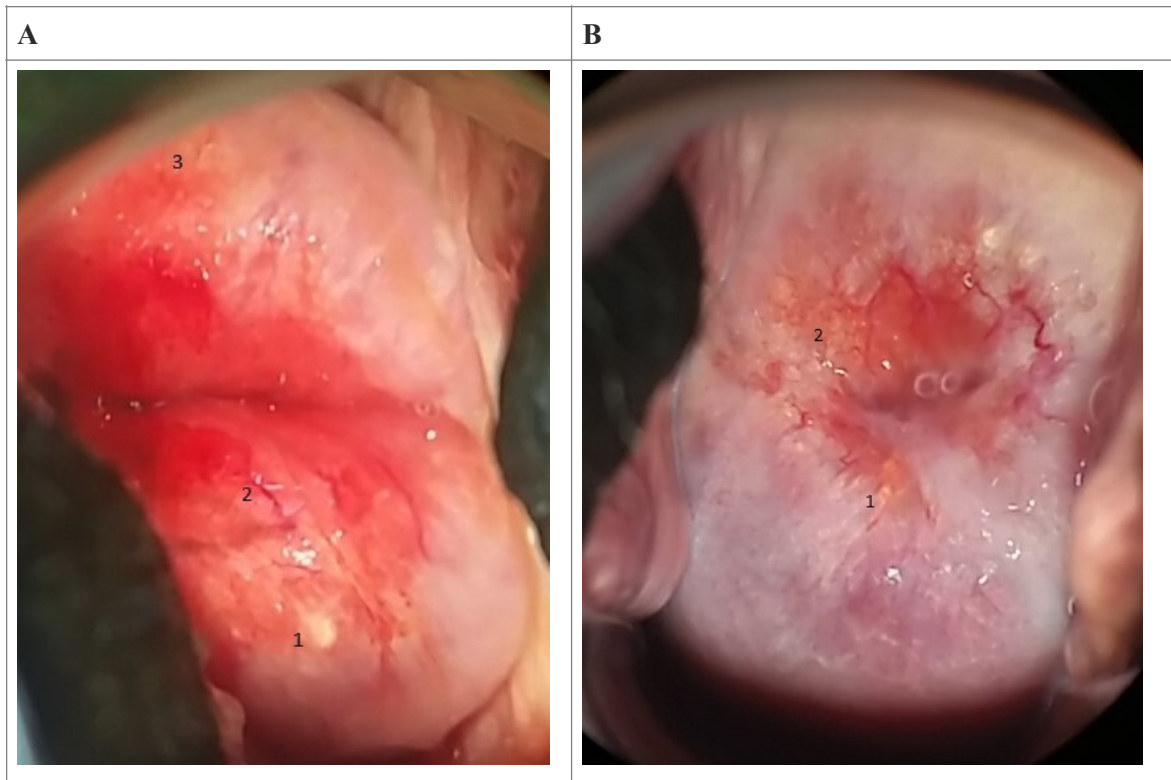
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For peer review only



## Sampling Flow Diagram





## Supplementary File 1

Close-ended structured questionnaire**A. Close ended structured questionnaire– Administered directly in English with oral translations into Fulbe, Kotoko, Mosgum, and Arab**

Name of Community: \_\_\_\_\_

Age (years): \_\_\_\_\_

Education: Informal education ( ) Formal education ( ) (specify) \_\_\_\_\_

Marital Status: Single ( ) Married ( ) Separated ( ) Widowed ( )

No of years having lived in community \_\_\_\_\_

Previous community \_\_\_\_\_

Economic activity-----

Residence ----- (collect coordinates)

**Questions on symptoms of urinary tract schistosomiasis; FGS; OR STI**

1. Do you see your menses? Yes ( ) No ( )
2. Did you observe/experience your menses within the last two weeks? Yes ( ) No ( ) Does your menses come every month? Regular?
3. Is your menses painful? \_\_\_\_\_(pain during menstruation – always very painful, sometimes painful, normal) Irregular? \_\_\_\_\_(every month?, not every month, stopped)
4. Do you have pain in your lower abdomen? When? For how long?
5. Do you have pain when urinating? Yes ( ) No ( )
6. Do you have difficulty in urinating (urine not coming out fluently)? Yes ( ) No ( )
7. Do you have sudden uncontrollable and unexpected urge to urinate and mostly cannot hold it? Even when you cough it comes out? Yes ( ) No ( )
8. Do you see blood in your urine? Yes ( ) No ( )
9. (If yes) When did you lastly see blood in your urine? \_\_\_\_\_Always, sometimes, Once in a while
10. Do you sometimes haveitching in your private part?Yes ( ) No ( )
11. How often do you experience this? Once a while ( ) frequently ( ) / When was the last time?
12. Do you have a feeling of burning within your private part? Yes ( ) No ( )

- 1  
2  
3 13. How often do you experience this? Once a while ( ) Frequently ( )  
4  
5 14. Do you sense a swelling/lumps within your private part? Yes ( ) No ( ) No response ( )  
6  
7 15. Do you have any discharge that comes from your vagina? Yes ( ) No ( ) Does it have an odour?  
8 \_\_\_\_\_ Do you see the colour? Yes ( ) No ( ) What Color is it? White; grey; green/yellow;  
9 brown  
10  
11  
12 16. Do you think this is normal? Yes ( ) No ( ) Do not know ( ). When did you start observing the  
13 discharge? Date \_\_\_\_\_  
14  
15 17. After sexual intercourse do you have a discharge? Yes ( ) No ( ) Is it smelly? Yes ( ) No ( ) Do not  
16 know ( )  
17 18. After or during sexual intercourse do you have pain? Yes ( ) No ( ) I do not know ( ) ; Do  
18 you have a bloody discharge? Yes ( ) No ( ) I do not know ( )  
19  
20 19. Have you had any miscarriages /pregnancies that passed? Yes ( ) No ( )  
21  
22 20. How many? ( )  
23  
24 21. Do you have children? Yes ( ) No ( )  
25  
26 22. What age is your last child? ( )  
27  
28 23. Have you visited the clinic to complain about these issues? Yes ( ) No ( )  
29  
30 24. What you used/taken/done to treat any of these problems? \_\_\_\_\_ (Underline) Hospital  
31 or drug store/ local midwife/ traditional medicine/ prayers/ none of the above (what other?  
32 Specify)/nothing  
33  
34  
35  
36

### Water contact History

- 37  
38  
39 1. Where do you fetch your household water? Lake; other source (name) \_\_\_\_\_  
40  
41 2. Do you fish in the lake? Yes ( ), No ( )  
42  
43 3. Do you bathe in the lake? Yes ( ), No ( )  
44  
45 4. What do you use the lake for? ( ) \_\_\_\_\_  
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## Supplementary file 2

**Analysis of deviance tables for both best fitting models (FGS and UGS), with *p*-values based on likelihood ratio tests**

Variable	Df	Deviance	Resid. Df	Resid. Dev	Pr(>Chi)
<b>UGS</b>					
Age2	2	19.0094	162	208.70	7.450e-05 ***
Lower Abdominal Pain	1	25.6949	161	183.01	3.999e-07 ***
Coital Pain	1	4.4254	160	178.58	0.03541 *
<b>FGS</b>					
Age2	2	9.8057	64	83.061	0.0074253 **
Coital Pain	1	11.3146	63	71.747	0.0007690 ***
Vaginal Itches	1	13.1740	62	58.573	0.0002839 ***
Lower Abdominal Pain	1	10.5961	61	47.976	0.0011333 **

**STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology\***  
**Checklist for cohort, case-control, and cross-sectional studies (combined)**

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-6
Objectives	3	State specific objectives, including any pre-specified hypotheses	6
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	7-10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	8-9
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	/
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-11
Bias	9	Describe any efforts to address potential sources of bias	/
Study size	10	Explain how the study size was arrived at	7-9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9-10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9-10
		(b) Describe any methods used to examine subgroups and interactions	10
		(c) Explain how missing data were addressed	7-8
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	/

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	/
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-13
		(b) Give reasons for non-participation at each stage	7-8
		(c) Consider use of a flow diagram	7
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11-13
		(b) Indicate number of participants with missing data for each variable of interest	/
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	/
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	/
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	/
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	11-13
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9, 12-15
		(b) Report category boundaries when continuous variables were categorized	9, 12-15
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	/
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	/
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	18-20
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	21
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21
Generalisability	21	Discuss the generalisability (external validity) of the study results	21
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	22

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Urogenital Schistosomiasis (UGS) and Female Genital Schistosomiasis (FGS) in Cameroon: An observational assessment of key reproductive health determinants of girls and women in the Matta Health Area

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Keywords:	Epidemiology < TROPICAL MEDICINE, PARASITOLOGY, Colposcopy < GYNAECOLOGY, Infection control < INFECTIOUS DISEASES

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2  
3 1 **Title:** Urogenital Schistosomiasis (UGS) and Female Genital Schistosomiasis (FGS) in Cameroon: An  
4 2 observational assessment of key reproductive health determinants of girls and women in the Matta  
5 3 Health Area  
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9 4

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1  
2  
3 26 **Abstract**  
4

5 27 **Objectives and Setting:** Across sub-Saharan Africa, urogenital schistosomiasis (UGS), in particular  
6  
7 28 female genital schistosomiasis (FGS) is a significant waterborne parasitic disease, with its direct burden  
8  
9 29 upon the sexual and reproductive health (SRH) of sufferers infrequently measured. UGS has an  
10  
11 30 established control plan, which in most endemic regions as in Cameroon, still excludes FGS  
12  
13 31 considerations. Highlighting existent associations between UGS and FGS could increase the  
14  
15 32 management of FGS within UGS interventions. This study seeks to identify current associations  
16  
17 33 amongst FGS and UGS with some reproductive health indicators, to provide formative information for  
18  
19 34 better integrated control.  
20  
21  
22

23 35 **Participants:** 304 females aged 5 - 69 years, were all examined for UGS by urine filtration and  
24  
25 36 microscopy. Amongst these, 193 women and girls were eligible for clinical FGS assessment based on  
26  
27 37 age (>13). After selective questioning for FGS symptoms, a sub-group of 67 women and girls consented  
28  
29 38 for clinical examination for FGS using portable colposcopy, with observed sequelae classified according  
30  
31 39 to the WHO FGS pocket atlas.  
32  
33

34 40 **Outcome:** Overall UGS and FGS prevalence was measured, with FGS/UGS related reproductive health  
35  
36 41 symptoms recorded. Associations between FGS and UGS were investigated by univariate and  
37  
38 42 multivariate logistic regression analyses.  
39  
40

41 43 **Results:** Overall UGS prevalence was 63.8% (194/304), where FGS prevalence (sub-group) was 50.7%  
42  
43 44 (34/67). FGS manifestation increased significantly with increasing age, whilst a significant decrease  
44  
45 45 with ascending age was observed for UGS. Lower abdominal pain (LAP) vaginal itches (VI), and coital  
46  
47 46 pain (CP), were identified as the main significant shared symptoms of both FGS and UGS, while LAP  
48  
49 47 with menstrual irregularity (MI) appeared a strong symptomatic indicator for FGS.  
50  
51

52 48 **Conclusion:** LAP, MI, CP and VI are potential SRH indicators that could be exploited in future for  
53  
54 49 targeting of praziquantel provision to FGS sufferers within primary care, complementary with existing  
55  
56 50 Praziquantel distribution for UGS sufferers in *S. haematobium* endemic areas.  
57  
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1  
2  
3 51 **Keywords:** *Schistosoma haematobium*, SRH, clinical colposcopy, questionnaires, menstrual health,  
4  
5 52 abdominal pain  
6  
7  
8 53

9  
10  
11 54 **Strengths and Limitations of this study**  
12

13 55 **Strength**

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15  
16 56 - This study used clinical colposcopy, which is the recommended diagnostic method for FGS, though  
17  
18 57 not very common within primary health care settings in sub-Saharan Africa.

19  
20 58 - Here, questionnaire approach is used to better capture individual experiences of FGS sufferers within  
21  
22 59 endemic areas for UGS.

23  
24 60 - Clinical diagnosis of girls younger than 14 (about half of the study participants) was not considered,  
25  
26 61 because of the invasive nature of colposcopy examination, especially as non-invasive clinical diagnostic  
27  
28 62 tools are lacking for examination amongst this age group within low resource schistosomiasis endemic  
29  
30 63 communities.

31 64 - Clinical diagnosis for FGS was carried out only on a limited sample

32  
33 65 - Assessment for STIs amongst participants are not presented here, whereby such results could  
34  
35 66 complement or clarify FGS diagnosis, considering most sexual and reproductive health related  
36  
37 67 symptoms for urogenital schistosomiasis present as sexually transmitted infections, and can be  
38  
39 68 misdiagnosed.

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77 **Introduction**

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3 78 In endemic areas, a definitive diagnosis of urogenital schistosomiasis (UGS) is established by  
4  
5 79 demonstration of viable *Schistosoma (S) haematobium* eggs ( $\geq 1$ ) in urine or hematuria[1-3], whilst  
6  
7 80 female genital schistosomiasis (FGS) can be diagnosed visually[4] for *S. haematobium* induced cervical  
8  
9 81 lesions and small fibrotic nodules known as “sandy patches”[5], either with the presence or absence of  
10  
11 82 *S. haematobium* eggs in urine[4, 6, 7]. Whilst both FGS and UGS are caused by infection with  
12  
13 83 *Schistosoma haematobium*[1, 4, 8, 9] a waterborne blood fluke, each appear to have some unclear  
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15 84 epidemiological associations, largely due to insufficient disease surveillance[6, 7, 10-13]. In sub-  
16  
17 85 Saharan Africa where UGS is endemic and can be highly prevalent ( $>50\%$ )[14, 15], insufficient or  
18  
19 86 infrequent efforts have been undertaken to document FGS specifically[11, 16-18], partly as the clinical  
20  
21 87 skills to do so are lacking and uninformed within primary care[10]. While active UGS does not readily  
22  
23 88 predict FGS[6], since FGS can occur without the direct presence of schistosome eggs in urine (a cardinal  
24  
25 89 diagnostic for UGS)[18, 19], rather FGS often presents with a more chronic time frame where  
26  
27 90 schistosome eggs are trapped within the cervico-vaginal surfaces[6, 20, 21]. For some, these trapped  
28  
29 91 eggs can accumulate from very early on in life[1], with enduring and typically hidden sequelae[20, 22].  
30  
31 92 Based on several biological determinants such as age[1], the mucosal damage and fibrotic scarring of  
32  
33 93 the vaginal and cervical surfaces from FGS proceeds with increasing duration of UGS[6]; moreover,  
34  
35 94 FGS-specific sequelae may be slow to resolve upon standard antiparasitic treatment of UGS[23, 24],  
36  
37 95 i.e., single annual administration of praziquantel at 40mg/g as used in public health campaigns[6, 13,  
38  
39 96 20].

40  
41  
42  
43 97 In many parts of Africa where surveillance of UGS is limited[25, 26] and that for FGS largely absent[15,  
44  
45 98 27], there is a clear need to better understand the epidemiological associations between UGS and  
46  
47 99 FGS[14]. Particularly so, to support earlier diagnosis of cases of FGS, and individualize praziquantel  
48  
49 100 treatment needs (for individual and context specific case management)[15, 28] to better avert their  
50  
51 101 disease progression[15]; as current interventions against UGS do not specifically target adolescent girls  
52  
53 102 or women[23, 29]. This gap in treatment coverage[28] and surveillance[13, 30] also has considerable  
54  
55 103 bearing on progress towards elimination of schistosomiasis transmission within disease endemic  
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57 104 communities[29].  
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3 105 In recent years, FGS focused research and public health education[31] has gained traction in certain  
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5 106 countries such as Ghana, Tanzania, Madagascar, Nigeria, and Mozambique[8, 9], although other  
6  
7 107 countries such as Cameroon, currently lag behind[32, 33]. Schistosomiasis exists in several regions of  
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9 108 Cameroon[34], affecting over 10 million people in rural and urban areas[35]. The country has a national  
10  
11 109 coordinated control plan for fairly early interventions during child-hood years (from 5 – 14 years  
12  
13 110 old)[36], which take advantage of school based intervention platforms[37, 38], and in certain settings,  
14  
15 111 community based interventions, where their at-risk status (people or communities dependent on  
16  
17 112 schistosomiasis endemic water bodies, for main water source) is high[21, 32, 36, 39, 40]. Even with  
18  
19 113 improved (>70%) helminth control amongst children in the last decade [35], some of the adolescent at-  
20  
21 114 risk populations do not always benefit from praziquantel treatment due to existing policy gaps and  
22  
23 115 program intervention challenges [[15, 41, 42].

24  
25  
26 116 To address this treatment deficit, capture missed opportunities, and ensure the consideration and  
27  
28 117 apprehension of ensuing FGS manifestations within such already identified sub-groups (young girls  
29  
30 118 and women); with better knowledge on the precise associations between UGS and FGS; future control  
31  
32 119 policies and intervention campaigns can be revised to better target at-risk populations.

33  
34 120 Here, we sought to clarify existing associations between FGS and UGS, highlighting cardinal  
35  
36 121 symptomologies for scalable detection and targeted control of FGS within UGS endemic areas. This  
37  
38 122 supports the need for a future integrated approach for control of schistosomiasis and limits the “gap”  
39  
40 123 concerning FGS surveillance within current primary care.

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## 44 45 125 **Materials and Methods**

### 46 47 48 126 **Ethics approval and consent to participate**

49  
50 127 Ethical clearance for this study was provided by the Cameroon National Ethics committee on Human  
51  
52 128 Health Research (Ref N ° 2020/07/1266/CE/CNERSH/SP), with administrative authorizations from  
53  
54 129 both the Regional Delegation of Public Health for the West region of Cameroon (Ref N°  
55  
56 130 679/L/MINSANTE/SG/DRSPO/CBF), and the district Health Office of the Malanteoun Health District  
57  
58 131 (Ref N° 078/L/MINSANTE/DRSPO/DSMLT). Informed written and oral consent was obtained from  
59  
60

1  
2  
3 132 all participants for parasitological and gynecological examinations. For participants <18 years, parents,  
4  
5 133 husbands, or guardian gave informed permission and assent was obtained from the participants. Privacy  
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7 134 and confidentiality of medical information were protected during and after the study.  
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9

### 10 135 **Patient and Public Involvement**

11  
12 136 We followed inclusive and participative methods to get overall participant and public involvement.  
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14 137 Tailored visits for data collection were carried out according to best practices with local engagement of  
15  
16 138 key community members and local health workers.  
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### 19 139 **Study Setting**

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21  
22 140 This study was carried out across a group of girls and women residing in remote communities  
23  
24 141 surrounding the Mape Dam, a known transmission focus for *Schistosoma haematobium*[35, 40] in the  
25  
26 142 Matta Health Area in Cameroon. Most study participants were involved actively in fishing or other  
27  
28 143 household activity that put them in constant contact with the lake water[33]. More than 90% of the  
29  
30 144 population lived less than 200m to infested water source (the Mape Dam), and more than 75% depended  
31  
32 145 fully on the Mape Dam for house-hold water and for an income generating activity (fishing) [13]. The  
33  
34 146 Matta Health Area hosts several remote fishing island communities that surround this man-made water  
35  
36 147 body, and for at least 18 years has witnessed high transmission of *s. haematobium* with prevalence of  
37  
38 148 UGS greater than 50% amongst children[43].  
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40

### 41 42 149 **Study Design and Procedures**

43  
44  
45 150 This cross-sectional study was conducted between December 2020 and June 2021. The total population  
46  
47 151 estimate of the study site was 5,000 [44], where females represented approximately 51.0%. About  
48  
49 152 54.6% of the population of females were aged 5-69 years. The sample size estimation for this study was  
50  
51 153 based on UGS prevalence (considered as key indicator for the study). With no existing records of UGS  
52  
53 154 prevalence amongst adults within the Matta Health area, a hypothesis of UGS endemicity amongst adults  
54  
55 155 was based on recorded school-age schistosomiasis prevalence (> 41% in the last decade) within the  
56  
57 156 Matta health Area[43, 45]. In this context made up of primarily fishing communities, more than 80% of  
58  
59 157 adults (both male and female) spent long stretches a day in contact with water (for economic -fishing-  
60

1  
2  
3 158 or household activity purposes) [37]. Based on this, we assumed UGS prevalence in such communities  
4  
5 159 should be higher amongst women. Hence, we resorted to an estimate of 55% for UGS prevalence in the  
6  
7 160 Matta health area, for our sample size calculation. Considering lake proximity and economic activities,  
8  
9 161 11 main communities were involved within the Matta Health Area: nine secluded water-locked fishing  
10  
11 162 communities (Islands/fishing camps) with habitations mostly less than 200m from the lake; and two  
12  
13 163 mainland communities (land-locked) with habitation more than 400m from the lake[33].

14  
15  
16 164 Following a simple random sampling technique, on the base of attaining a precision rate of 95% with  
17  
18 165 an error margin of 5%, our initial sample size was estimated using the sample size formula for prevalence  
19  
20 166 studies [46] given by  $n = N * X / (X + N - 1)$ , where  $X = Z^2 * p * (1-p) / MOE^2$ , and  $Z = Z_{\alpha/2}$  is the critical  
21  
22 167 value of the normal distribution at  $\alpha/2$  (for confidence level of 95%,  $\alpha$  is 0.05 and critical value is 1.96),  
23  
24 168 MOE is the margin of error (5%),  $p$  is an estimate of UGS prevalence in the study area (fixed at 55%),  
25  
26 169 and  $N$  is the population of females in the study area (1400). The Finite Population Correction was applied  
27  
28 170 to the sample size formula. Thus,  $n = 1400 * 3.8 / (3.8 + 1400 - 1) = 387$ . With an originally determined  
29  
30 171 sample size of 387, due to logistic and cultural constraints, 304 (78.55%) of target recruitment was  
31  
32 172 reached [33].

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35  
36 173 A secondary objective in this study was also to find out reproductive health determinants for FGS. For  
37  
38 174 that, a sub-sample of 67 females was obtained from the 304 women enrolled in the study (Figure 1).  
39  
40 175 Eligibility criteria for this sub-group consisted of the following: being 14 years old (considered as  
41  
42 176 minimum marriage age in this context) and above, not virgin, not menstruating at present, not pregnant,  
43  
44 177 and consent/assent from parent or spouse for girls younger than 18. Hence, of the 304 participants  
45  
46 178 enrolled and tested for UGS, 193 were eligible for clinical FGS assessment based on age (Figure 1).  
47  
48 179 However, due to participant availability, logistic constraints, and consent amongst others, only 67  
49  
50 180 amongst 193 participants were available for clinical FGS diagnosis.

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53 181 Questionnaires related to sexual and reproductive health characteristics were administered to  
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55 182 participants based on age and question sensitivity. Hence, varying denominators for different variables.  
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3 183 Due to the secluded nature of study communities (far from health care settings), and the preference of a  
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5 184 participative nature for recruiting (involvement of formal/informal health workers and some community  
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7 185 members), recruitment was contextualized within each community as per the propositions of key  
8  
9 186 community members (including participants themselves).

11  
12 187 Within the sub-group for FGS diagnosis, after questioning (questionnaire), consenting participants  
13  
14 188 underwent gynecological examination by colposcopy with photo documentation by a trained midwife.

15  
16 189 All participants were recruited and screened within the community, mostly in their homes or a 'safe'  
17  
18 190 house prescribed by the women themselves, or the village leader.

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22  
23 192 **Figure 1: Study participant selection criteria and numbers with diagnostic methods flow**

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29 194 Thus, after UGS assessment, a structured questionnaire (see Supplementary File 1) with FGS related  
30  
31 195 symptoms [33], sexual and reproductive health, and socio-demographic questions, was administered  
32  
33 196 privately in a one-to-one format to all consenting/assenting participants, mostly based on age and  
34  
35 197 question sensitivity. For girls younger than 14, questions linked to sexual health were avoided, and other  
36  
37 198 questioning also depended on parent/guardian availability for aiding/complementing their responses or  
38  
39 199 responding directly for them. For girls/women older than 14, both reproductive and sexual health related  
40  
41 200 questions were asked where possible. Participants responded to the structured questionnaire and were  
42  
43 201 prompted to discuss further on related symptoms if they wished to share.

44  
45  
46  
47 202 Sexual and reproductive health related questions included: sexual activeness, (with age of first encounter  
48  
49 203 or age at marriage), number of children, age of last child, any miscarriage, menstrual irregularities or  
50  
51 204 abnormalities (collected as irregular, painful or ceased menstruation), abdominal pain, coital pain, and  
52  
53 205 vaginal itches with abnormal discharges. Demographic questions asked included: age, level of formal  
54  
55 206 or informal schooling achieved, water contact activities, and income generating activities. Most females  
56  
57 207 encountered during initial sample enrolment were married by age 14, which helped guide the minimum  
58  
59 208 age for the study, in terms of deciphering a general baseline for assessing girls for FGS (through general

1  
2  
3 209 sexual health related questions, and invasive gynecological examination). Also, age at marriage was  
4  
5 210 used to determine/suggest sub-fertility amongst participants as the age of first child, last child and  
6  
7 211 presence or absence of children was deciphered from the number of years in marriage (or being sexually  
8  
9 212 active) [33, 47]. Hence, sub fertility was considered as marriage age + youngest child= 4+, while  
10  
11 213 infertility referred to marriage age + no child. To better explore age-related profiles, three age groups  
12  
13 214 were formed around these context specific sexual and reproductive health characteristics: adolescence  
14  
15 215 (14-19), young adults (20-35) and older adults (36+).

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### 20 21 217 **Parasitological and Gynecological Examinations**

22  
23  
24 218 Dipstick diagnosis of microscopic hematuria[48], and urine syringe filtration technique with  
25  
26 219 microscopic-based poly-carbonate filter examination for urinary eggs, were used on a single urine  
27  
28 220 sample for standard UGS detection within this study. At least 10 ml of urine was collected and observed  
29  
30 221 for macrohematuria, tested for microhematuria and proteinuria with reagent strips (Siemens Multistix  
31  
32 222 10 SG), then analyzed for *S. haematobium* eggs, at the local health center laboratory on the same day of  
33  
34 223 collection. Microscopy for visualization of schistosome eggs was performed by x100 mag. using a light  
35  
36 224 compound microscope and stained with Lugol's iodine. A urine sample was counted positive for UGS  
37  
38 225 on the presence of hematuria[3] or at least one terminal-spined ovum seen[49]. The number of ova  
39  
40 226 reported were classified as  $\geq 50$  (high intensity) or  $< 50$  (low intensity)[2]. Next, consenting eligible  
41  
42 227 girls and women were examined by clinical colposcopy with photo-documentation, using a hand-held  
43  
44 228 colposcope (EVA COLPO, Mobile ODT). The obtained images were cross-checked against the WHO  
45  
46 229 FGS pocket atlas[5] to record key sequelae. These were then saved in a coded database for the internal  
47  
48 230 validation through blinded evaluation of cervical images from photo-colposcopy by external team  
49  
50 231 members, following the cross examination with the WHO Pocket atlas. A minimal clinical indication  
51  
52 232 for FGS was determined upon the presence of sandy patches, abnormal blood vessels and/or sandy  
53  
54 233 patches on homogenous yellow areas, in line with the WHO FGS pocket atlas coding[5] after cross  
55  
56 234 verification by external specialists.

235

## 236 **Statistical Analysis**

237 All numerical data collected were first imputed into computer system using the Microsoft excel database  
238 and later imported into the R (version 4.0.2) software for statistical analyses. In univariate analysis,  
239 frequencies and proportions were reported for socio-demographic, syndromic and clinical variables. In  
240 bivariate analysis, Pearson's chi-squared tests were used to test the association between the socio-  
241 demographic, clinical and syndromic reproductive health related variables (which serve as independent  
242 variables), against the dependent variables FGS and UGS. To further highlight such dependence,  
243 univariate logistic regression analyses was used, with the results presented in the form of unadjusted  
244 odds ratios. To identify most relevant variables amongst the reproductive health related independent  
245 variables associated to each of UGS and FGS, multivariate logistic regressions analyses were used, with  
246 the results presented in the form of adjusted odds ratios (AOR), alongside 95% confidence intervals (CI)  
247 and *p*-values based on the Wald's Test. To fit the models, only factors significantly related to the  
248 outcomes at a 25% level of significance in the univariate models were included. Multicollinearity  
249 between independent variables in the initial multivariate models were evaluated using the `vif` function  
250 in the `car` R package and our knowledge on how the variables were measured. The `step` function in  
251 the R package `stats` was applied to the resulting multivariate models after correcting for  
252 multicollinearity to select the "best" fitting model. The global significance of variables in the final  
253 models were evaluated based on analysis of deviance tables using the `anova` function in the `stats` R  
254 package. In all, the level of significance was set at *p*-value <0.05.

255

## 256 **Results**

### 257 **A. General participant characteristics**

258 A total sample population of 304 females were enrolled, and all diagnosed for UGS, aged from 5 to 69  
259 years old (193 of reproductive age, >13 and <70, with mean±SD age of 28 ±12.7). Also, 88.16%  
260 of participants were dependent on, and lived within a proximity of ≤200m to the Mape lake (Island

communities), and the remaining 11.82% came from Mainland communities, which were further from the lake (>400m), having alternative water sources (wells and stand taps), and involved in farming alone without fishing activities. A prevalence of 63.8% (194/304) for UGS was recorded from egg prevalence or hematuria. Furthermore, 27.30% showed proteinuria, and a 51.0% prevalence (155/304) was recorded for hematuria (with 19 showing macrohematuria). Microhematuria sensitivity and specificity was calculated against egg positivity, with a specificity and sensitivity of 80.00% (95% CI: 73.58 – 86.42) and 73.83% (95% CI: 66.91 – 80.75) respectively. The Geometric Mean Egg (GME) count was 33.1 (Range: 2 – 1220) among which 36.2% had heavy ( $\geq 50$  eggs/10ml of urine) infection while 63.8% had light (> 50 eggs/10ml of urine) infection. Macrohematuria was strongly related to egg density categories ( $\chi^2 = 17.7$ ;  $P < 0.001$ ), where cases of macrohematuria were directly related to heavy egg load (93.2%). Information related to sub fertility/infertility was captured based on age at marriage, number of children and the age of last child; with more than half of the study population reporting not having received treatment with praziquantel in more than a year (see Table 1). Reported sexual and reproductive health syndromes included miscarriages (58.89%), lower abdominal pain (56.95%), lower back pain (44.59%), coital pain (45.98%), coital bleeding (37.93), vaginal itches (68%), abnormal vaginal discharge (42.6%) and menstrual irregularities (47.74%), all seen to be comparatively higher amongst participants, compared to stress incontinence (19.47) (see Table 1).

Table 1: General characteristics of all study participants (Sociodemographic, syndromic, clinical)

Variable	Category	Number of Women	Percentage
<b>1. Demographic</b>			
Age (groups) ( <i>n=304/304*</i> )	<14	111	36.51
	[14-20[	62	20.39
	[20-36[	83	27.3
	36+	48	15.79
Menarche( <i>n=304/304*</i> )	Pre	98	32.24
	Post	206	67.76
Age at marriage ( <i>n=178/193*</i> )	[13-15[	71	39.89
	[15-18[	88	49.44
	18+	19	10.67
No of Children ( <i>n=181/193*</i> )	0	44	24.31
	[1-3]	72	39.78
	[26]	37	20.44
	7+	28	15.47
Age of last child ( <i>n=130/137*</i> )	0+	10	7.69
	[1-3]	67	51.54
	[26]	15	11.54
	7+	38	29.23
Treatment with praziquantel ( <i>n=304/304*</i> )	< 12 months	1	0.3
	> 12 months	292	96.1

	Never	11	3.6
Economic Activity ( <i>n</i> =241/304*)	Fishing (with/without farming)	211	87.5
	Farming (without fishing)	30	12.4
Proximity to lake ( <i>n</i> =304/304*)	<200m	268	88.16
	>400m	36	11.84
<b>2. Syndromic</b>			
Lower Abdominal Pain( <i>n</i> =223/304*)	Yes	127	56.95
Coital Pain( <i>n</i> =174/193*)	Yes	80	45.98
Coital bleeding( <i>n</i> =174/193*)	Yes	66	37.93
Vaginal Itches( <i>n</i> =225/304*)	Yes	153	68.00
Vaginal Discharge( <i>n</i> =214/304*)	Yes	90	42.06
External genital Itch( <i>n</i> =206/304*)	Yes	86	41.75
Lower back Pain( <i>n</i> =223/304*)	Yes	99	44.59
Stress Incontinence( <i>n</i> =226/304*)	Yes	44	19.47
Menstrual Irregularities( <i>n</i> =199/206*)	Yes	95	47.74
Fertility( <i>n</i> =178/193*)	Sub fertility	158	88.8%
	Infertility	20	11.2%
Miscarriages( <i>n</i> =180/193*)	0	74	41.11
	1+	106	58.89
<b>3. Clinical</b>			
Parasitemia( <i>n</i> =304/304*)	0	141	46.38
	[1-50]	104	34.21
	50+	59	19.41
Hematuria( <i>n</i> =304/304*)	+	155	51.0
Proteinuria( <i>n</i> =304/304*)	+	83	27.30

\*Shows the eligible sample size for each variable. For age of marriage (*n*=178/193\*) for example, 178 out of the 193 eligible women gave information their marriage age, meaning 15 women had missing information for the variable.

### 1. UGS Characteristics amongst sample population

Table 2 presents the relationship between UGS as a dependent factor and each of the sociodemographic and reported reproductive health characteristics based on chi-square tests of independence and univariate logistic regression. The results indicate that the chances of UGS infection amongst women who lived more than 400m from the lake was 0.36 (95% CI: 0.17-0.72) times that of women who lived less than 200m to the lake, implying that significant odds of being infected with UGS was seen with closer lake proximity. A significant decrease in chances of infection with urogenital schistosomiasis was observed with increasing age. Relative to girls <14 years, girls between 14-19 years had a 0.46 (95% CI: 0.22-0.95) odds of having UGS, as opposed to 0.29 (95% CI: 0.15-0.54) odds for adults ranging from 20-35 years, and 0.09 (95% CI: 0.04-0.19) odds for women older than 35 years. All reported reproductive health syndromes showed significant relationship with UGS, except for stress incontinence (UOR 1.72 [95% CI: 0.87-3.54]  $p=0.1287$ ). In effect, women with lower abdominal pain, coital pain, vaginal itch, menstrual irregularity, and coital bleeding showed significantly higher odds (Table 2) of UGS.

295

296 **Table 2:** Relations between UGS and each socio-demographic and syndromic variable in the study  
 297 sample

Variables	Category	n	Chi2 test of Independence			Univariate logistic regression			
			UGS – n (%)	UGS + n (%)	P-value	Unadjusted OR (95% C.I.)		P value	
Age group (n=304)	<14	111	20 (18.2)	91 (46.9)	<0.0001	1			
	[14-20[	62	20 (18.2)	42 (21.6)		0.46	(0.22, 0.95)		0.0352
	[20-36[	83	36 (32.7)	47 (24.2)		0.29	(0.15, 0.54)		0.0002
	36+	48	34 (30.9)	14 (7.2)		0.09	(0.04, 0.19)		<0.0001
No of Children (n=181)	0	44	15 (18.1)	29 (29.6)	0.0462	1			
	[1-3]	72	33 (39.8)	39 (39.8)		0.61	(0.28, 1.32)		0.2143
	[4-6]	37	16 (19.3)	21 (21.4)		0.68	(0.27, 1.67)		0.3994
	7+	28	19 (22.9)	9 (9.2)		0.25	(0.09, 0.66)		0.0063
Age of Last Child (n=130)	0+	10	4 (6)	6 (9.5)	0.0323	1			
	[1-3]	67	33 (49.3)	34 (54)		0.69	(0.16, 2.62)		0.5863
	[4-6]	15	4 (6)	11 (17.5)		1.83	(0.33, 10.6)		0.4862
	7+	38	26 (38.8)	12 (19)		0.31	(0.07, 1.27)		0.1082
Miscarriages (n=180)	0	74	41 (48.8)	33 (34.4)	0.1055	1			
	1	52	19 (22.6)	33 (34.4)		2.16	(1.05, 4.52)		0.0382
	2+	54	24 (28.6)	30 (31.2)		1.55	(0.77, 3.17)		0.2216
Lower Abdominal Pain(n=223)	Yes	127	42 (45.2)	85 (65.4)	0.0039	2.29 (1.33, 3.98)		0.0028	
Coital Pain(n=174)	Yes	80	25 (30.5)	55 (59.8)	0.0001	3.39 (1.82, 6.43)		0.0001	
Coital bleeding(n=174)	Yes	66	19 (23.2)	47 (51.1)	0.0002	3.46 (1.82, 6.79)		0.0002	
Vaginal Itches(n=225)	Yes	153	51 (53.7)	102 (78.5)	0.0001	3.14 (1.77, 5.67)		0.0001	
Abnormal Vaginal Discharge (n=214)	Yes	90	27 (29)	63 (52.1)	0.0008	2.66 (1.51, 4.76)		0.0008	
Lower Back Pain(n=222)	Yes	99	34 (36.6)	65 (50.4)	0.0551	1.76 (1.03, 3.06)		0.0416	
Stress Incontinence(n=226)	Yes	44	14 (14.7)	30 (22.9)	0.1729	1.72 (0.87, 3.54)		0.1287	
Genital Itches(n=206)	Yes	86	26 (28.6)	60 (52.2)	0.0007	2.73 (1.53, 4.94)		0.0008	
Menstrual Irregularity(n=199)	Yes	95	29 (33)	66 (59.5)	0.0002	2.98 (1.68, 5.4)		0.0002	
Proximity to lake	<20m	268	89 (80.9)	179 (92.3)	0.0051	1			
	>200m	36	21 (19.1)	15 (7.7)		0.36	(0.17, 0.72)		0.0042

298

### 299 **Multivariate Logistic Regression Model for Reporting Sexual and Reproductive Health (SRH)** 300 **Risk Factors related to UGS**

301 After including all variables significantly related to UGS at a 25% level in a multivariate model,  
 302 multicollinearity issues were suspected between lower abdominal pain and lower back pain, and external  
 303 genital itch and vaginal itches. However, considering genital itch responses were most often related to  
 304 vaginal itch or misreported by respondents due to their literal similarity in Pidgin English or Fulbe used  
 305 during questioning, we resorted to keeping only vaginal itches in the model. Similarly for lower back  
 306 pain and lower abdominal pain because of the similarity in responses, but with a more comprehensive  
 307 responding for lower abdominal pain, lower back pain was removed. The resulting “best” fitting model  
 308 included age group, lower abdominal pain, and coital pain as the most significant sexual and  
 309 reproductive health risk factors for UGS (Table 3). In this result, we also observed a decreasing trend in

number of cases of UGS with increasing age. Also, the odds of infection in women with lower abdominal pain was 6.42 (95% CI: 2.85 - 15.68) times that for women without the pain. The odds of infection in women with coital pain was 2.16 (95% CI: 1.05 – 4.46) times that for women without the pain.

**Table 3:** Possible risk factors for UGS amongst the socio-demographic and SRH included in the study. A multivariate logistic regression model on the effects of sexual and reproductive health factors significantly related to UGS.

SRH Indicator	Category	Adjusted OR (95% C.I.)	P value
Age group	[14-20[	1.0	
	20-36[	0.28 (0.10, 0.70)	0.0087
	36+	0.11 (0.04, 0.31)	0.0001
Lower Abdominal Pain	No	1.0	
	Yes	6.42 (2.85, 15.68)	0.0000
Coital Pain	No	1.0	
	Yes	2.16 (1.05, 4.46)	0.0362

## 2. FGS Characteristics amongst study participants (Sub-group)

Of the total number of participants examined for FGS after UGS ( $n=67$ ), 40 were confirmed to have ova-patent UGS, and 34 for FGS, upon the presence of homogenous yellow sandy patches, grainy sandy patches, and abnormal blood vessels (Figure 2). A breakdown of UGS/FGS within the subset of 67 women examined for FGS showed: 26 FGS+/UGS+; 8 FGS+/UGS-; 14 FGS-/UGS+; and 19 FGS-/UGS-. Related reproductive health syndromes (as reported in UGS), similarly, were all found to have some association ( $P < 0.05$ ) with FGS manifestation amongst females (Table 4), except for stress incontinence. Of import amongst these, menstrual irregularities or abnormality, also found with UGS, was seen to have 7.9 times higher odds of affecting women with FGS than women without FGS (Table 4). Back pain was seen to significantly affect women with FGS manifestations than was the case with UGS. Similarly, odds of having FGS manifestations were seen to ascend with age (Table 4), unlike UGS which was significant with descending age. Lower abdominal pain, menstrual irregularity and lower back pain showed the highest odds of manifesting amongst women with FGS.

**Figure 2:** Imagery of FGS pathology of the cervix with reported lesions (magnification x4)

332 **A)** 1-rubbery papule, 2-abnormal blood vessel, 3- homogeneous sandy patch (30-year-old woman,  
 333 +UGS, +lower abdominal pain, +Menstrual irregularity); **B)** 1,2- grainy sandy patches (45-year-old  
 334 woman, -UGS, +lower abdominal pain; +Menstrual irregularity)

335  
 336 **Table 4:** Relations between FGS and socio-demographic and syndromic variables in the sub-group of  
 337 girls and women diagnosed for FGS

Variables( <i>n</i> =67)	Category	N	Chi2 Test of Independence			Univariate logistic regression				
			FGS – n(%)	FGS + n(%)	P-value	Unadjusted OR (95% C.I.)		P value		
Age group	[14-20[	19	15 (45.5)	4 (11.8)	0.0091	1	(1.73, 26.1)	0.0077		
	[20-36[	29	11 (33.3)	18 (52.9)		6.14				
	36+	19	7 (21.2)	12 (35.3)		6.43			(1.62, 30.35)	0.0116
Age at Marriage	[13-15[	23	10 (30.3)	13 (38.2)	0.1286	1	(0.19, 1.58)	0.2765		
	[15-18[	38	22 (66.7)	16 (47.1)		0.56				
	18+	6	1 (3)	5 (14.7)		3.85			(0.51, 79.99)	0.2510
No of Children	0	16	12 (36.4)	4 (11.8)	0.0363	1	(0.64, 11.23)	0.2024		
	[1-3]	22	12 (36.4)	10 (29.4)		2.5				
	[4-6]	15	4 (12.1)	11 (32.4)		8.25			(1.79, 46.95)	0.0102
	7+	14	5 (15.2)	9 (26.5)		5.4			(1.19, 28.98)	0.0357
Age of Last Child	0+	1	1 (4.8)	0 (0)	0.1199	1	(0, Inf)	0.9965		
	[1-3]	27	14 (66.7)	13 (46.4)		Inf				
	[4-6]	4	0 (0)	4 (14.3)		Inf			(0, Inf)	0.9937
	7+	17	6 (28.6)	11 (39.3)		Inf			(0, Inf)	0.9963
Miscarriages	0	26	18 (54.5)	8 (23.5)	0.0362	1	(1.22, 13.78)	0.0256		
	1	22	8 (24.2)	14 (41.2)		3.94				
	2+	19	7 (21.2)	12 (35.3)		3.86			(1.14, 14.19)	0.0343
Lower Abdominal Pain	Yes	47	15 (45.5)	32 (94.1)	0	19.2	(4.74, 131.08)	0.0003		
Coital Pain	Yes	32	10 (30.3)	22 (64.7)	0.0071	4.22	(1.55, 12.16)	0.0058		
Coital bleeding	Yes	29	8 (24.2)	21 (61.8)	0.0029	5.05	(1.82, 15.19)	0.0026		
Vaginal Itches	Yes	49	18 (54.5)	31 (91.2)	0.0009	8.61	(2.44, 40.95)	0.0021		
Vaginal Discharge	Yes	32	9 (27.3)	23 (67.6)	0.0014	5.58	(2.01, 16.67)	0.0013		
Back Pain	Yes	41	12 (36.4)	29 (85.3)	0	10.15	(3.31, 36.45)	0.0001		
Stress Incontinence	Yes	10	0 (0)	10 (29.4)	0.0009	Inf	(0, Inf)	0.9927		
Genital Itch	Yes	32	9 (27.3)	23 (67.6)	0.0014	5.58	(2.01, 16.67)	0.0013		
Menstrual irregularities	Yes	34	9 (27.3)	25 (73.5)	0.0002	7.41	(2.61, 23)	0.0003		
Proximity	<20m	60	30 (90.9)	30 (88.2)	1	1	(0.27, 7.25)	0.7212		
	>200m	7	3 (9.1)	4 (11.8)	1	1.33				

338  
 339 **Multivariate Logistic Regression Model for Reporting Sexual and Reproductive Health (SRH)**  
 340 **Risk Factors related to FGS**

341 Similar to UGS, a multivariate model was constructed with all variables significantly related to FGS at  
 342 a 25% level. As well, multicollinearity checks revealed lower back pain and genital itch (for same  
 343 reasons) with the variables age group, coital pain, vaginal itches, and lower abdominal pain (Table 5)  
 344 retained in the “best” fitting model.

345  
 346



347 **Table 5:** Possible risk factors amongst SRH for FGS. A multivariate logistic regression model on the  
 348 effects of FGS on sexual and reproductive health factors.

SRH Indicator	Category	Adjusted OR (95% C.I.)	P value
Age group	[14-20[		
	[20-36[	20.15 (2.92, 240.94)	0.0061
	36+	41.29 (4.16, 946.69)	0.0054
Coital Pain	No	1.0	
	Yes	10.44 (2.12, 90.91)	0.0105
Vaginal Itches	No	1.0	
	Yes	12.50 (1.92, 128.77)	0.0151
Lower Abdominal Pain	No	1.0	
	Yes	28.80 (3.36, 578.24)	0.0081

349

### 350 3. UGS, FGS and associations with reproductive health characteristics

351 Age, number of children, age of last child, menstrual abnormality, miscarriages, and lower abdominal  
 352 pain were identified as possible reproductive health factors associated with *S. haematobium* infection  
 353 and were used within this study. Generally, both FGS and UGS were not significantly ( $P$ -value  $>0.05$ )  
 354 related to number of children, age of last child and miscarriages. In multivariate logistic regression  
 355 models, after selection of the best fitting models, the results show that the most significant risk factors  
 356 for UGS are age group, lower abdominal pain and coital pain (Table 4), whereas age-group and lower  
 357 abdominal pain, coital pain and vaginal itches were identified as the most significant risk factors for  
 358 FGS (Table 5). Chances of FGS manifestations amongst women with lower abdominal pain was AOR  
 359 9.5(95% CI:1.7-81.8) times that of women without the pain (Table 5). Analysis of deviance tables for  
 360 both best fitting models (FGS and UGS), with  $p$ -values based on likelihood ratio tests are reported in  
 361 Supplementary File 2.

362

### 363 Discussion

364 Understanding the risks and associations of UGS and FGS, especially within different contexts of  
 365 women's health[41, 50], sheds greater light on the disease epidemiology, which could foster improved  
 366 and coordinated control measures both locally and nationally[41]. Furthermore, precisely documenting  
 367 existing associations between both UGS and FGS could clarify further the need for precision mapping

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3 368 of schistosomiasis in endemic regions, for formulating a better targeted integrated response[48]. Though  
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5 369 a non-significant association was observed between egg intensity in urine and FGS from the onset of  
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7 370 this study (Table 2), parasitemia association has been shown to be misleading in UGS[7, 12, 13] from  
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9 371 several other studies[13] and reports on FGS, particularly when only a single urine sample is examined  
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11 372 which is usually the case for population-based surveillance[6]. Considering this, questionnaire (for  
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13 373 symptoms)[10, 21], as well as visual examination of cervix and vaginal walls by colposcopy[12, 18,  
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15 374 51], offers an added strength to single sample urinalysis for detection of FGS, as carried out in this study,  
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17 375 and several others[10, 18]. The possibility of the presence of FGS in UGS populations has been often  
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19 376 raised[8, 21], with projections of about 360 million girls and women possibly having UGS[15], but today  
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21 377 it is thought that at least 56 million adolescent girls and women are suffering from FGS[15, 17]. Our  
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23 378 results seem to show an even higher rate of FGS amongst the UGS infected population with an  
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25 379 approximate FGS/UGS ratio of 34/40. Our study, given our application of portable colposcopy, is the  
26  
27 380 first formal attempt to document the pathology of FGS in a primary care setting in Cameroon.

30  
31 381 Elsewhere, the clinical pathology of FGS has been described resulting from the complex inflammatory  
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33 382 responses to antigens released by adult worms and viable eggs[6, 14], which persists until sometime  
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35 383 after adult worms are stopped egg-laying or are destroyed by praziquantel[24]. Thereafter, various signs  
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37 384 and symptoms (or effects) may present months or even years after treatment[23, 42].

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40 385 From present results, and within the general literature[15, 17], one of such effects noted is an effect on  
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42 386 menstrual health. More than half of women within the study who reported poor menstrual health (FGS  
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44 387 = 73.5%; UGS = 54.6%), either as irregular, painful or seized menstruation, were found to either shed  
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46 388 eggs in urine (positive for UGS), or were positive for FGS, but without eggs in urine; showing more  
47  
48 389 women positive for FGS reporting abnormal menstruation, than for UGS. This confirms recent  
49  
50 390 analysis[17, 33] and suggests strong linkages between menstrual health management and FGS[15, 17],  
51  
52 391 an under researched area. This can be credited to the fact that symptoms perhaps diminished after a  
53  
54 392 while with UGS (maybe as a result of treatment in mass drug administration campaigns), but later  
55  
56 393 resurface with more chronic sequelae of FGS[17], and with more dire symptoms and negative impact  
57  
58 394 on menstrual health[17, 33]. In our study context, post-menarche females already faced a substantial  
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3 395 challenge with limited access to hygienic material and information on menstrual health management,  
4  
5 396 typically relying on self-made clothes and absorbent plant leaves during menstruation, due to lack of  
6  
7 397 finances or general knowledge.  
8  
9

10 398 Still related to FGS and menstrual health, narratives from a previous study[33] which used qualitative  
11  
12 399 probing showed women having manifestations of FGS and not shedding eggs in urine, gave a history of  
13  
14 400 having lived in their earlier years in heavily infested *S. haematobium* foci. This explained their later  
15  
16 401 manifestation of FGS symptoms, even after having moved away to a less infested area, with more than  
17  
18 402 90% limit in fresh water contact[33]. This is similar to our findings, where lake proximity was seen to  
19  
20 403 be not very significant to FGS manifestation (Table 4), same as egg shedding, still pointing to early-in-  
21  
22 404 life infection and later chronicity. Significant difference in menstrual abnormalities amongst UGS  
23  
24 405 positive women [n=22(56.4)] and UGS negative women [n=12 (44.4)], alerts to future chronicity of  
25  
26 406 FGS after UGS, especially if not managed with more readily available praziquantel treatment(s)[42, 52].  
27  
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29  
30 407 On its own, lower abdominal pain observed significant association (in adjusted and unadjusted  
31  
32 408 regression models) in both UGS and FGS. The chances of having lower abdominal pain were  
33  
34 409 significantly higher in females with either FGS (94.1%) or UGS (84.2%). Similarly with coital pain and  
35  
36 410 vaginal itches, these reported as key indicators for UGS and FGS, directing early diagnosis of UGS and  
37  
38 411 future FGS in endemic communities, thereby promoting the verticalization of control strategies for both  
39  
40 412 diseases.  
41

42  
43 413 Another trend observed in this study is that intensity of infection or egg patent-prevalence (for UGS)  
44  
45 414 reduces while chronic disease or morbidity for FGS increases as women age. The chances of FGS after  
46  
47 415 UGS increased significantly (AOR 6.43,95% C.I 1.62-30.35, P=0.0091) as women aged (36+). Similar  
48  
49 416 findings have been reported in other studies in different geographical locations[6, 14, 53, 54] and  
50  
51 417 recently in this area[33]; emphasizing on the level of present intensity for UGS, and possible future  
52  
53 418 occurrence of FGS[14, 54]. UGS at a younger age will in some cases manifest into FGS when the female  
54  
55 419 is older[14], causing more intense gynecological symptoms and effects. This offers a possible guiding  
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57 420 tool for better control policies, related to early diagnosis and treatment[41, 55]. This surpasses need  
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3 421 alone for school-based MDAs[13, 28, 56], but considers and encourages individual therapy in different  
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5 422 contexts for FGS (and MGS)[6].  
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7

8 423 Although only a few amongst the extensive list of reproductive health determinants [54] were identified  
9  
10 424 in this study to be statistically significant, where mostly reported symptoms were collected, clinical and  
11  
12 425 biological examinations carried out, enabled confirmation of how future self-reported symptoms with  
13  
14 426 UGS and FGS might be best used[33]. These results support the advocated need for further attention on  
15  
16 427 post-transmission schistosomiasis[57], and also, the availability of praziquantel in lowest level (Health  
17  
18 428 Areas and community) health care for individual therapy[54], as well as treatment from a younger  
19  
20 429 age[15, 28, 41, 52], buoyed with the recent development of pediatric praziquantel[58].  
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### 23 430 **Study Limitations**

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26 431 Though described as gold standard[49], active UGS was only detected through observation of eggs in  
27  
28 432 urine samples by microscopic-based poly-carbonate filter examination, as well as recommended dipstick  
29  
30 433 assays for urinary hematuria detection. Alternative molecular assays such as polymerase chain reaction  
31  
32 434 (PCR) for schistosome detection in human serum and urine samples[12], were not considered for added  
33  
34 435 sensitivity for UGS and FGS (in vaginal lavage analysis)[3, 59]. Though recommended[12, 21], only  
35  
36 436 visual examination through inspection for lesions on the cervix, the fornices, and the vaginal walls with  
37  
38 437 a colposcope[5, 51] and screening with questionnaires[10] was considered in the detection of FGS in  
39  
40 438 this study. Lastly, clinical diagnosis of FGS was carried out only on a limited sub-group of females,  
41  
42 439 where more precise conclusions may be obtained by using an appropriate sample size.  
43  
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45

### 46 440 **Conclusion**

47  
48 441 Whilst millions of women in Cameroon have UGS, its epidemiological connection with FGS is not  
49  
50 442 fully appreciated, which creates an unfortunate knowledge holdup for effective control at the public  
51  
52 443 health level. In our chosen study location, which is broadly typical for endemic areas of UGS in  
53  
54 444 Cameroon[21, 34, 36, 40], strong epidemiological associations between UGS and FGS were found  
55  
56 445 against certain key sexual and reproductive determinants: age, lower abdominal pain and menstrual  
57  
58 446 health. This formative knowledge could be utilized to tackle and ultimately prevent FGS, with a more  
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3 447 targeted integrated control for UGS in Cameroon and elsewhere in endemics areas for UGS globally.  
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5 448 This study further adds detailed insight into the connection of FGS and UGS within primary care in  
6  
7 449 endemic communities, denoting those with cardinal symptomologies more explicitly for scalable  
8  
9 450 detection and targeted control of FGS within UGS endemic areas.  
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## 12 452 **Supporting Files**

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15  
16 453 Supplementary File 1.docx : Structured questionnaire

17  
18 454 Supplementary File 2.docx: Deviance Table

19 455

## 20 21 22 456 **Declarations**

### 23 24 457 • **Authors' contributions**

25  
26  
27 458 MCM and JRS conceptualized the study and planned the methodology; AEN,VG, MCM, carried out  
28  
29 459 field investigation; MCM, FNB, JRS, ASO, AEN, analyzed and interpreted the data for this manuscript;  
30  
31 460 MCM acquired funding for study and wrote the original draft of the manuscript; JRS supervised the  
32  
33 461 study and was a major contributor in the conceptualization and writing of the manuscript; AEN,  
34  
35 462 coordinated field activities within the Malanteoun Health District; AEN, FNB, VG, ASO, reviewed and  
36  
37 463 edited the manuscript. All authors approved the final version of the paper before submission.  
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40 464

### 41 42 43 44 465 • **Competing interests**

45  
46  
47 466 The authors declare that they have no competing interests.  
48  
49

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4  
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8 474 • **Data Sharing Statement**  
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10  
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12  
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13 502 • **Consent for publication**

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16 503 Written informed consent for publication of clinical details and/or clinical images was obtained from  
17  
18 504 the patients and parents/guardians where needed.

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25  
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27  
28  
29

30 664 • **Figure Legends**

31 665 **Figure 1: Study participant selection criteria and numbers with diagnostic methods flow**

32  
33  
34 666 **Figure 2: Imagery of FGS pathology of the cervix with reported lesions (magnification of x4)**

35  
36 667 **A)** 1-rubbery papule, 2-abnormal blood vessel, 3- homogeneous sandy patch (30-year-old woman, +UGS, +lower  
37 668 abdominal pain, +Menstrual irregularity); **B)** 1,2- grainy sandy patches (45-year-old woman, -UGS, +lower  
38 669 abdominal pain; +Menstrual irregularity)  
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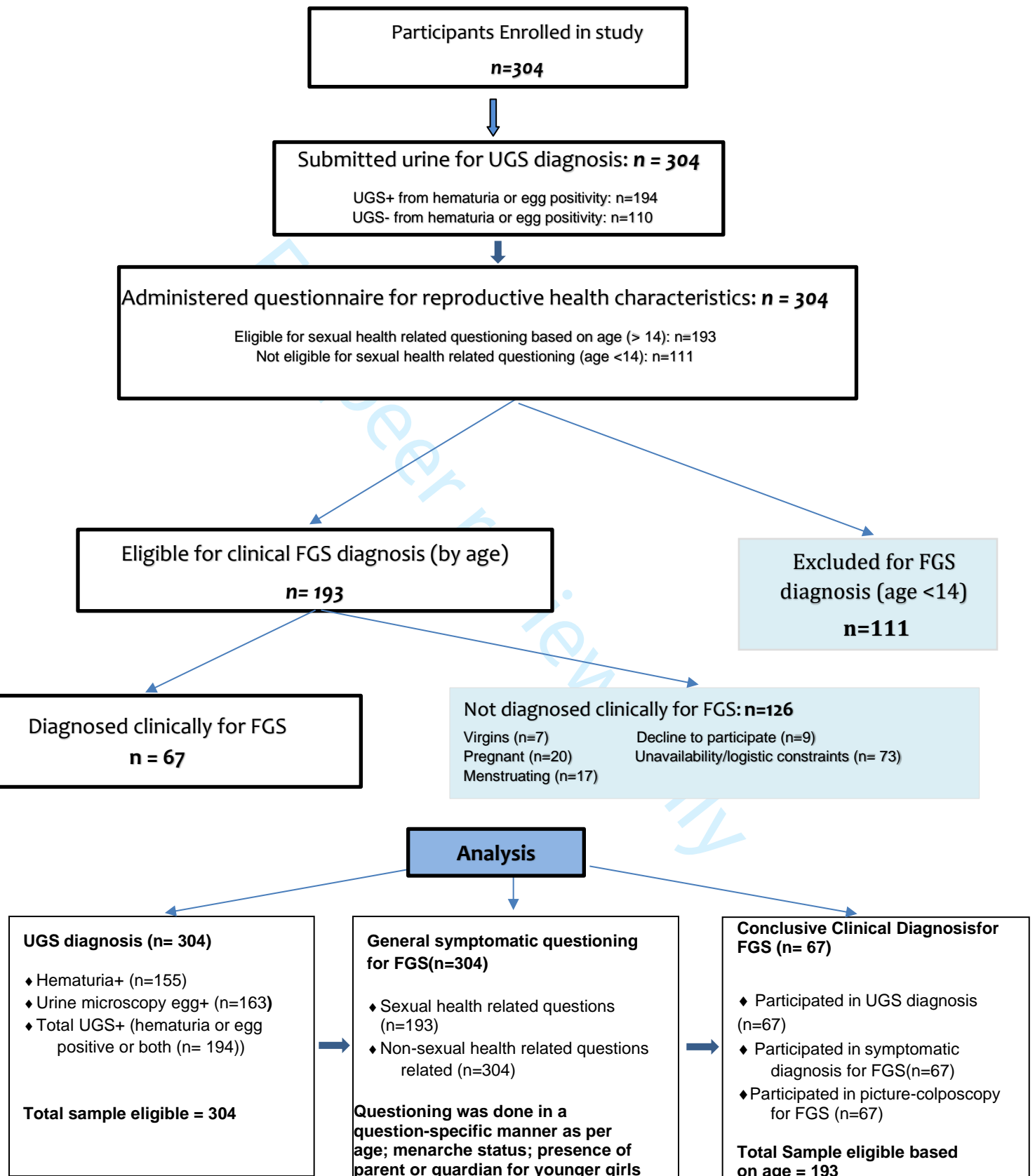
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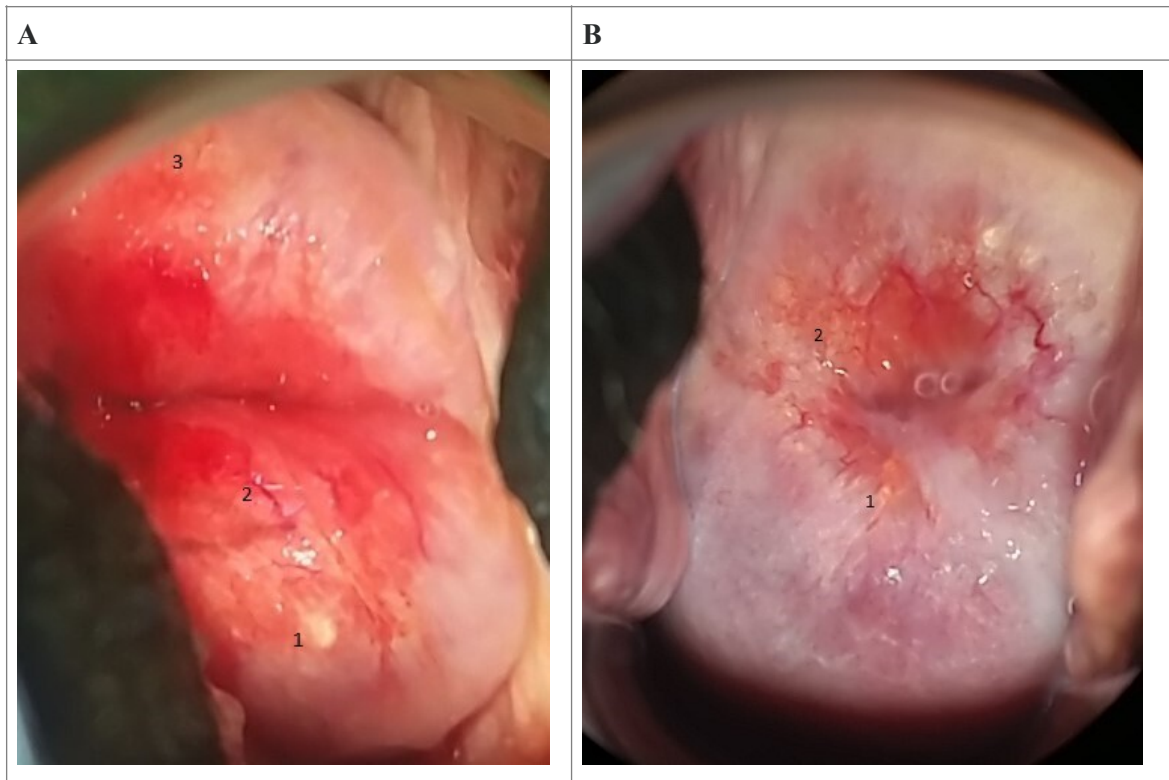
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## Sampling Flow Diagram





## Supplementary File 1

Close-ended structured questionnaire**A. Close ended structured questionnaire– Administered directly in English with oral translations into Fulbe, Kotoko, Mosgum, and Arab**

Name of Community: \_\_\_\_\_

Age (years): \_\_\_\_\_

Education: Informal education ( ) Formal education ( ) (specify) \_\_\_\_\_

Marital Status: Single ( ) Married ( ) Separated ( ) Widowed ( )

No of years having lived in community \_\_\_\_\_

Previous community \_\_\_\_\_

Economic activity-----

Residence ----- (collect coordinates)

**Questions on symptoms of urinary tract schistosomiasis; FGS; OR STI**

1. Do you see your menses? Yes ( ) No ( )
2. Did you observe/experience your menses within the last two weeks? Yes ( ) No ( ) Does your menses come every month? Regular?
3. Is your menses painful? \_\_\_\_\_(pain during menstruation – always very painful, sometimes painful, normal) Irregular? \_\_\_\_\_(every month?, not every month, stopped)
4. Do you have pain in your lower abdomen? When? For how long?
5. Do you have pain when urinating? Yes ( ) No ( )
6. Do you have difficulty in urinating (urine not coming out fluently)? Yes ( ) No ( )
7. Do you have sudden uncontrollable and unexpected urge to urinate and mostly cannot hold it? Even when you cough it comes out? Yes ( ) No ( )
8. Do you see blood in your urine? Yes ( ) No ( )
9. (If yes) When did you lastly see blood in your urine? \_\_\_\_\_Always, sometimes, Once in a while
10. Do you sometimes haveitching in your private part?Yes ( ) No ( )
11. How often do you experience this? Once a while ( ) frequently ( )/ When was the last time?
12. Do you have a feeling of burning within your private part? Yes ( ) No ( )

1  
2  
3 13. How often do you experience this? Once a while ( ) Frequently ( )  
4

5 14. Do you sense a swelling/lumps within your private part? Yes ( ) No ( ) No response ( )  
6

7 15. Do you have any discharge that comes from your vagina? Yes ( ) No ( ) Does it have an odour?  
8

9 \_\_\_\_\_ Do you see the colour? Yes ( ) No ( ) What Color is it? White; grey; green/yellow;  
10

11 brown  
12

13 16. Do you think this is normal? Yes ( ) No ( ) Do not know ( ). When did you start observing the  
14 discharge? Date \_\_\_\_\_  
15

16 17. After sexual intercourse do you have a discharge? Yes ( ) No ( ) Is it smelly? Yes ( ) No ( ) Do not  
17 know ( )  
18

19 18. After or during sexual intercourse do you have pain? Yes ( ) No ( ) I do not know ( ) ; Do  
20 you have a bloody discharge? Yes ( ) No ( ) I do not know ( )  
21

22 19. Have you had any miscarriages /pregnancies that passed? Yes ( ) No ( )  
23

24 20. How many? ( )  
25

26 21. Do you have children? Yes ( ) No ( )  
27

28 22. What age is your last child? ( )  
29

30 23. Have you visited the clinic to complain about these issues? Yes ( ) No ( )  
31

32 24. What you used/taken/done to treat any of these problems? \_\_\_\_\_ (Underline) Hospital  
33 or drug store/ local midwife/ traditional medicine/ prayers/ none of the above (what other?  
34 Specify)/nothing  
35  
36

### 37 **Water contact History**

38 1. Where do you fetch your household water? Lake; other source (name) \_\_\_\_\_  
39

40 2. Do you fish in the lake? Yes ( ), No ( )  
41

42 3. Do you bathe in the lake? Yes ( ), No ( )  
43

44 4. What do you use the lake for? ( ) \_\_\_\_\_  
45  
46  
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## Supplementary file 2

**Analysis of deviance tables for both best fitting models (FGS and UGS), with *p*-values based on likelihood ratio tests**

Variable	Df	Deviance	Resid. Df	Resid. Dev	Pr(>Chi)
<b>UGS</b>					
Age2	2	19.0094	162	208.70	7.450e-05 ***
Lower Abdominal Pain	1	25.6949	161	183.01	3.999e-07 ***
Coital Pain	1	4.4254	160	178.58	0.03541 *
<b>FGS</b>					
Age2	2	9.8057	64	83.061	0.0074253 **
Coital Pain	1	11.3146	63	71.747	0.0007690 ***
Vaginal Itches	1	13.1740	62	58.573	0.0002839 ***
Lower Abdominal Pain	1	10.5961	61	47.976	0.0011333 **

**STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology\***  
**Checklist for cohort, case-control, and cross-sectional studies (combined)**

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-6
Objectives	3	State specific objectives, including any pre-specified hypotheses	6
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	7-10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	8-9
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	/
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-11
Bias	9	Describe any efforts to address potential sources of bias	/
Study size	10	Explain how the study size was arrived at	7-9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9-10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9-10
		(b) Describe any methods used to examine subgroups and interactions	10
		(c) Explain how missing data were addressed	7-8
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	/



		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	/
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-13
		(b) Give reasons for non-participation at each stage	7-8
		(c) Consider use of a flow diagram	7
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11-13
		(b) Indicate number of participants with missing data for each variable of interest	/
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	/
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	/
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	/
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	11-13
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9, 12-15
		(b) Report category boundaries when continuous variables were categorized	9, 12-15
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	/
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	/
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	18-20
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	21
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21
Generalisability	21	Discuss the generalisability (external validity) of the study results	21
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	22

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Urogenital Schistosomiasis (UGS) and Female Genital Schistosomiasis (FGS) in Cameroon: An observational assessment of key reproductive health determinants of girls and women in the Matta Health Area

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<b>Primary Subject Heading</b>:	Public health
Secondary Subject Heading:	Infectious diseases, Epidemiology
Keywords:	Epidemiology < TROPICAL MEDICINE, PARASITOLOGY, Colposcopy < GYNAECOLOGY, Infection control < INFECTIOUS DISEASES

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1  
2  
3 1 **Title:** Urogenital Schistosomiasis (UGS) and Female Genital Schistosomiasis (FGS) in Cameroon: An  
4 2 observational assessment of key reproductive health determinants of girls and women in the Matta  
5 3 Health Area  
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9 4

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1  
2  
3 **26 Abstract**  
4

5 **27 Objectives and Setting:** Across sub-Saharan Africa, urogenital schistosomiasis (UGS), in particular  
6  
7 **28** female genital schistosomiasis (FGS) is a significant waterborne parasitic disease, with its direct burden  
8  
9 **29** upon the sexual and reproductive health (SRH) of sufferers infrequently measured. UGS has an  
10  
11 **30** established control plan, which in most endemic regions as in Cameroon, still excludes FGS  
12  
13 **31** considerations. Highlighting existent associations between UGS and FGS could increase the  
14  
15 **32** management of FGS within UGS interventions. This study seeks to identify current associations  
16  
17 **33** amongst FGS and UGS with some reproductive health indicators, to provide formative information for  
18  
19 **34** better integrated control.  
20  
21  
22

23 **35 Participants:** 304 females aged 5 - 69 years, were all examined for UGS by urine filtration and  
24  
25 **36** microscopy. Amongst these, 193 women and girls were eligible for clinical FGS assessment based on  
26  
27 **37** age (>13). After selective questioning for FGS symptoms, a sub-group of 67 women and girls consented  
28  
29 **38** for clinical examination for FGS using portable colposcopy, with observed sequelae classified according  
30  
31 **39** to the WHO FGS pocket atlas.  
32  
33

34 **40 Outcome:** Overall UGS and FGS prevalence was measured, with FGS/UGS related reproductive health  
35  
36 **41** symptoms recorded. Associations between FGS and UGS were investigated by univariate and  
37  
38 **42** multivariate logistic regression analyses.  
39  
40

41 **43 Results:** Overall UGS prevalence was 63.8% (194/304), where FGS prevalence (sub-group) was 50.7%  
42  
43 **44** (34/67). FGS manifestation increased significantly with increasing age, whilst a significant decrease  
44  
45 **45** with ascending age was observed for UGS. Lower abdominal pain (LAP) vaginal itches (VI), and coital  
46  
47 **46** pain (CP), were identified as the main significant shared symptoms of both FGS and UGS, while LAP  
48  
49 **47** with menstrual irregularity (MI) appeared a strong symptomatic indicator for FGS.  
50  
51

52 **48 Conclusion:** LAP, MI, CP and VI are potential SRH indicators that could be exploited in future for  
53  
54 **49** targeting of praziquantel provision to FGS sufferers within primary care, complementary with existing  
55  
56 **50** Praziquantel distribution for UGS sufferers in *S. haematobium* endemic areas.  
57  
58  
59  
60

1  
2  
3 51 **Keywords:** *Schistosoma haematobium*, SRH, clinical colposcopy, questionnaires, menstrual health,  
4  
5 52 abdominal pain  
6  
7  
8 53  
9

## 10 54 **Strengths and Limitations of this study**

### 11 55 **Strengths**

- 12  
13  
14  
15  
16 56 - This study used clinical colposcopy, which is the recommended diagnostic method for FGS, though  
17  
18 57 not very common within primary health care settings in sub-Saharan Africa.  
19  
20 58 - Here, questionnaire approach is used to better capture individual experiences of FGS sufferers within  
21  
22 59 endemic areas for UGS.

### 23 60 **Limitations**

- 24  
25  
26 61 - Clinical diagnosis of girls younger than 14 (about half of the study participants) was not considered,  
27  
28 62 because of the invasive nature of colposcopy examination, especially as non-invasive clinical diagnostic  
29  
30 63 tools are lacking for examination amongst this age group within low resource schistosomiasis endemic  
31  
32 64 communities.  
33  
34 65 - Clinical diagnosis for FGS was carried out only on a limited sample  
35  
36 66 - Assessment for STIs amongst participants are not presented here, whereby such results could  
37  
38 67 complement or clarify FGS diagnosis, considering most sexual and reproductive health related  
39  
40 68 symptoms for urogenital schistosomiasis present as sexually transmitted infections, and can be  
41  
42 69 misdiagnosed.

40 70

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## 48 78 **Introduction**

1  
2  
3 79 In endemic areas, a definitive diagnosis of urogenital schistosomiasis (UGS) is established by  
4  
5 80 demonstration of viable *Schistosoma (S) haematobium* eggs ( $\geq 1$ ) in urine or hematuria[1-3], whilst  
6  
7 81 female genital schistosomiasis (FGS) can be diagnosed visually[4] for *S. haematobium* induced cervical  
8  
9 82 lesions and small fibrotic nodules known as “sandy patches”[5], either with the presence or absence of  
10  
11 83 *S. haematobium* eggs in urine[4, 6, 7]. Whilst both FGS and UGS are caused by infection with  
12  
13 84 *Schistosoma haematobium*[1, 4, 8, 9] a waterborne blood fluke, each appear to have some unclear  
14  
15 85 epidemiological associations, largely due to insufficient disease surveillance[6, 7, 10-13]. In sub-  
16  
17 86 Saharan Africa where UGS is endemic and can be highly prevalent ( $>50\%$ )[14, 15], insufficient or  
18  
19 87 infrequent efforts have been undertaken to document FGS specifically[11, 16-18], partly as the clinical  
20  
21 88 skills to do so are lacking and uninformed within primary care[10]. While active UGS does not readily  
22  
23 89 predict FGS[6], since FGS can occur without the direct presence of schistosome eggs in urine (a cardinal  
24  
25 90 diagnostic for UGS)[18, 19], rather FGS often presents with a more chronic time frame where  
26  
27 91 schistosome eggs are trapped within the cervico-vaginal surfaces[6, 20, 21]. For some, these trapped  
28  
29 92 eggs can accumulate from very early on in life[1], with enduring and typically hidden sequelae[20, 22].  
30  
31 93 Based on several biological determinants such as age[1], the mucosal damage and fibrotic scarring of  
32  
33 94 the vaginal and cervical surfaces from FGS proceeds with increasing duration of UGS[6]; moreover,  
34  
35 95 FGS-specific sequelae maybe slow to resolve upon standard antiparasitic treatment of UGS[23, 24],  
36  
37 96 i.e., single annual administration of praziquantel at 40mg/g as used in public health campaigns[6, 13,  
38  
39 97 20].  
40  
41  
42  
43

44 98 In many parts of Africa where surveillance of UGS is limited[25, 26] and that for FGS largely absent[15,  
45  
46 99 27], there is a clear need to better understand the epidemiological associations between UGS and  
47  
48 100 FGS[14]. Particularly so, to support earlier diagnosis of cases of FGS, and individualize praziquantel  
49  
50 101 treatment needs (for individual and context specific case management)[15, 28] to better avert their  
51  
52 102 disease progression[15]; as current interventions against UGS do not specifically target adolescent girls  
53  
54 103 or women[23, 29]. This gap in treatment coverage[28] and surveillance[13, 30] also has considerable  
55  
56 104 bearing on progress towards elimination of schistosomiasis transmission within disease endemic  
57  
58 105 communities[29].  
59  
60

1  
2  
3 106 In recent years, FGS focused research and public health education[31] has gained traction in certain  
4  
5 107 countries such as Ghana, Tanzania, Madagascar, Nigeria, and Mozambique[8, 9], although other  
6  
7 108 countries such as Cameroon, currently lag behind[32, 33]. Schistosomiasis exists in several regions of  
8  
9 109 Cameroon[34], affecting over 10 million people in rural and urban areas[35]. The country has a national  
10  
11 110 coordinated control plan for fairly early interventions during child-hood years (from 5 – 14 years  
12  
13 111 old)[36], which take advantage of school based intervention platforms[37, 38], and in certain settings,  
14  
15 112 community based interventions, where their at-risk status (people or communities dependent on  
16  
17 113 schistosomiasis endemic water bodies, for main water source) is high[21, 32, 36, 39, 40]. Even with  
18  
19 114 improved (>70%) helminth control amongst children in the last decade [35], some of the adolescent at-  
20  
21 115 risk populations do not always benefit from praziquantel treatment due to existing policy gaps and  
22  
23 116 program intervention challenges [[15, 41, 42].

24  
25  
26 117 To address this treatment deficit, capture missed opportunities, and ensure the consideration and  
27  
28 118 apprehension of ensuing FGS manifestations within such already identified sub-groups (young girls  
29  
30 119 and women); with better knowledge on the precise associations between UGS and FGS; future control  
31  
32 120 policies and intervention campaigns can be revised to better target at-risk populations.

33  
34  
35 121 Here, we sought to clarify existing associations between FGS and UGS, highlighting cardinal  
36  
37 122 symptomologies for scalable detection and targeted control of FGS within UGS endemic areas. This  
38  
39 123 supports the need for a future integrated approach for control of schistosomiasis and limits the “gap”  
40  
41 124 concerning FGS surveillance within current primary care.

42  
43 125

## 44 45 126 **Materials and Methods**

### 46 47 48 127 **Ethics approval and consent to participate**

49  
50 128 Ethical clearance for this study was provided by the Cameroon National Ethics committee on Human  
51  
52 129 Health Research (Ref N ° 2020/07/1266/CE/CNERSH/SP), with administrative authorizations from  
53  
54 130 both the Regional Delegation of Public Health for the West region of Cameroon (Ref N°  
55  
56 131 679/L/MINSANTE/SG/DRSPO/CBF), and the district Health Office of the Malantouen Health District  
57  
58 132 (Ref N° 078/L/MINSANTE/DRSPO/DSMLT). Informed written and oral consent was obtained from  
59  
60



1  
2  
3 133 all participants for parasitological and gynecological examinations. For participants <18 years, parents,  
4  
5 134 husbands, or guardian gave informed permission and assent was obtained from the participants. Privacy  
6  
7 135 and confidentiality of medical information were protected during and after the study.  
8  
9

### 10 136 **Patient and Public Involvement**

11  
12 137 We followed inclusive and participative methods to get overall participant and public involvement.  
13  
14 138 Tailored visits for data collection were carried out according to best practices with local engagement of  
15  
16 139 key community members and local health workers.  
17  
18

### 19 140 **Study Setting**

20  
21  
22 141 This study was carried out across a group of girls and women residing in remote communities  
23  
24 142 surrounding the Mape Dam, a known transmission focus for *Schistosoma haematobium*[35, 40] in the  
25  
26 143 Matta Health Area in Cameroon. Most study participants were involved actively in fishing or other  
27  
28 144 household activity that put them in constant contact with the lake water[33]. More than 90% of the  
29  
30 145 population lived less than 200m to infested water source (the Mape Dam), and more than 75% depended  
31  
32 146 fully on the Mape Dam for house-hold water and for an income generating activity (fishing) [13]. The  
33  
34 147 Matta Health Area hosts several remote fishing island communities that surround this man-made water  
35  
36 148 body, and for at least 18 years has witnessed high transmission of *s. haematobium* with prevalence of  
37  
38 149 UGS greater than 50% amongst children[43].  
39  
40  
41

### 42 150 **Study Design and Procedures**

43  
44  
45 151 This cross-sectional study was conducted between December 2020 and June 2021. The total population  
46  
47 152 estimate of the study site was 5,000 [44], where females represented approximately 51.0%. About  
48  
49 153 54.6% of the population of females were aged 5-69 years. The sample size estimation for this study was  
50  
51 154 based on UGS prevalence (considered as key indicator for the study). With no existing records of UGS  
52  
53 155 prevalence amongst adults within the Matta Health area, a hypothesis of UGS endemicity amongst adults  
54  
55 156 was based on recorded school-age schistosomiasis prevalence (> 41% in the last decade) within the  
56  
57 157 Matta health Area[43, 45]. In this context made up of primarily fishing communities, more than 80% of  
58  
59 158 adults (both male and female) spent long stretches a day in contact with water (for economic -fishing-  
60

1  
2  
3 159 or household activity purposes) [37]. Based on this, we assumed UGS prevalence in such communities  
4  
5 160 should be higher amongst women. Hence, we resorted to an estimate of 55% for UGS prevalence in the  
6  
7 161 Matta health area, for our sample size calculation. Considering lake proximity and economic activities,  
8  
9 162 11 main communities were involved within the Matta Health Area: nine secluded water-locked fishing  
10  
11 163 communities (Islands/fishing camps) with habitations mostly less than 200m from the lake; and two  
12  
13 164 mainland communities (land-locked) with habitation more than 400m from the lake[33].  
14  
15

16 165 Following a simple random sampling technique, on the base of attaining a precision rate of 95% with  
17  
18 166 an error margin of 5%, our initial sample size was estimated using the sample size formula for prevalence  
19  
20 167 studies [46] given by  $n = N * X / (X + N - 1)$ , where  $X = Z^2 * p * (1-p) / MOE^2$ , and  $Z = Z_{\alpha/2}$  is the critical  
21  
22 168 value of the normal distribution at  $\alpha/2$  (for confidence level of 95%,  $\alpha$  is 0.05 and critical value is 1.96),  
23  
24 169 MOE is the margin of error (5%),  $p$  is an estimate of UGS prevalence in the study area (fixed at 55%),  
25  
26 170 and  $N$  is the population of females in the study area (1400). The Finite Population Correction was applied  
27  
28 171 to the sample size formula. Thus,  $n = 1400 * 3.8 / (3.8 + 1400 - 1) = 387$ . With an originally determined  
29  
30 172 sample size of 387, due to logistic and cultural constraints, 304 (78.55%) of target recruitment was  
31  
32 173 reached [33].  
33  
34  
35

36 174 A secondary objective in this study was also to find out reproductive health determinants for FGS. For  
37  
38 175 that, a sub-sample of 67 females was obtained from the 304 women enrolled in the study (Figure 1).  
39  
40 176 Eligibility criteria for this sub-group consisted of the following: being 14 years old (considered as  
41  
42 177 minimum marriage age in this context) and above, not virgin, not menstruating at present, not pregnant,  
43  
44 178 and consent/assent from parent or spouse for girls younger than 18. Hence, of the 304 participants  
45  
46 179 enrolled and tested for UGS, 193 were eligible for clinical FGS assessment based on age (Figure 1).  
47  
48 180 However, due to participant availability, logistic constraints, and consent amongst others, only 67  
49  
50 181 amongst 193 participants were available for clinical FGS diagnosis.  
51  
52

53 182 Questionnaires related to sexual and reproductive health characteristics were administered to  
54  
55 183 participants based on age and question sensitivity. Hence, varying denominators for different variables.  
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2  
3 184 Due to the secluded nature of study communities (far from health care settings), and the preference of a  
4  
5 185 participative nature for recruiting (involvement of formal/informal health workers and some community  
6  
7 186 members), recruitment was contextualized within each community as per the propositions of key  
8  
9 187 community members (including participants themselves).

11  
12 188 Within the sub-group for FGS diagnosis, after questioning (questionnaire), consenting participants  
13  
14 189 underwent gynecological examination by colposcopy with photo documentation by a trained midwife.

15  
16 190 All participants were recruited and screened within the community, mostly in their homes or a 'safe'  
17  
18 191 house prescribed by the women themselves, or the village leader.

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20  
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22  
23 193 **Figure 1: Study participant selection criteria and numbers with diagnostic methods flow**

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29 195 Thus, after UGS assessment, a structured questionnaire (see Supplementary File 1) with FGS related  
30  
31 196 symptoms [33], sexual and reproductive health, and socio-demographic questions, was administered  
32  
33 197 privately in a one-to-one format to all consenting/assenting participants, mostly based on age and  
34  
35 198 question sensitivity. For girls younger than 14, questions linked to sexual health were avoided, and other  
36  
37 199 questioning also depended on parent/guardian availability for aiding/complementing their responses or  
38  
39 200 responding directly for them. For girls/women older than 14, both reproductive and sexual health related  
40  
41 201 questions were asked where possible. Participants responded to the structured questionnaire and were  
42  
43 202 prompted to discuss further on related symptoms if they wished to share.

44  
45  
46  
47 203 Sexual and reproductive health related questions included: sexual activeness, (with age of first encounter  
48  
49 204 or age at marriage), number of children, age of last child, any miscarriage, menstrual irregularities or  
50  
51 205 abnormalities (collected as irregular, painful or ceased menstruation), abdominal pain, coital pain, and  
52  
53 206 vaginal itches with abnormal discharges. Demographic questions asked included: age, level of formal  
54  
55 207 or informal schooling achieved, water contact activities, and income generating activities. Most females  
56  
57 208 encountered during initial sample enrolment were married by age 14, which helped guide the minimum  
58  
59 209 age for the study, in terms of deciphering a general baseline for assessing girls for FGS (through general

1  
2  
3 210 sexual health related questions, and invasive gynecological examination). To better explore age-related  
4  
5 211 profiles, three age groups were formed around these context specific sexual and reproductive health  
6  
7 212 characteristics: adolescence (14-19 years), young adults (20-35 years) and older adults (36+ years). The  
8  
9 213 first age group can be considered to represent active marriage period in this study area, the second,  
10  
11 214 period of high conception probability, and third, post conception period [47].  
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### 217 **Parasitological and Gynecological Examinations**

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23  
24 218 Dipstick diagnosis of microscopic hematuria[48], and urine syringe filtration technique with  
25  
26 219 microscopic-based poly-carbonate filter examination for urinary eggs, were used on a single urine  
27  
28 220 sample for standard UGS detection within this study. At least 10 ml of urine was collected and observed  
29  
30 221 for macrohematuria, tested for microhematuria and proteinuria with reagent strips (Siemens Multistix  
31  
32 222 10 SG), then analyzed for *S. haematobium* eggs, at the local health center laboratory on the same day of  
33  
34 223 collection. Microscopy for visualization of schistosome eggs was performed by x100 mag. using a light  
35  
36 224 compound microscope and stained with Lugol's iodine. A urine sample was counted positive for UGS  
37  
38 225 on the presence of hematuria[3] or at least one terminal-spined ovum seen[49]. The number of ova  
39  
40 226 reported were classified as  $\geq 50$  (high intensity) or  $< 50$  (low intensity)[2]. Next, consenting eligible  
41  
42 227 girls and women were examined by clinical colposcopy with photo-documentation, using a hand-held  
43  
44 228 colposcope (EVA COLPO, Mobile ODT). The obtained images were cross-checked against the WHO  
45  
46 229 FGS pocket atlas[5] to record key sequelae. These were then saved in a coded database for the internal  
47  
48 230 validation through blinded evaluation of cervical images from photo-colposcopy by external team  
49  
50 231 members, following the cross examination with the WHO Pocket atlas. A minimal clinical indication  
51  
52 232 for FGS was determined upon the presence of sandy patches, abnormal blood vessels and/or sandy  
53  
54 233 patches on homogenous yellow areas, in line with the WHO FGS pocket atlas coding[5] after cross  
55  
56 234 verification by external specialists.  
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## 236 **Statistical Analysis**

237 All numerical data collected were first imputed into computer system using the Microsoft excel database  
238 and later imported into the R (version 4.0.2) software for statistical analyses. In univariate analysis,  
239 frequencies and proportions were reported for socio-demographic, syndromic and clinical variables. In  
240 bivariate analysis, Pearson's chi-squared tests were used to test the association between the socio-  
241 demographic, clinical and syndromic reproductive health related variables (which serve as independent  
242 variables), against the dependent variables FGS and UGS. To further highlight such dependence,  
243 univariate logistic regression analyses was used, with the results presented in the form of unadjusted  
244 odds ratios. To identify most relevant variables amongst the reproductive health related independent  
245 variables associated to each of UGS and FGS, multivariate logistic regressions analyses were used, with  
246 the results presented in the form of adjusted odds ratios (AOR), alongside 95% confidence intervals (CI)  
247 and *p*-values based on the Wald's Test. To fit the models, only factors significantly related to the  
248 outcomes at a 25% level of significance in the univariate models were included. Multicollinearity  
249 between independent variables in the initial multivariate models were evaluated using the `vif` function  
250 in the `car` R package and our knowledge on how the variables were measured. The step function in  
251 the R package `stats` was applied to the resulting multivariate models after correcting for  
252 multicollinearity to select the "best" fitting model. The global significance of variables in the final  
253 models were evaluated based on analysis of deviance tables using the `anova` function in the `stats` R  
254 package. In all, the level of significance was set at *p*-value <0.05.

## 256 **Results**

### 257 **A. General participant characteristics**

258 A total sample population of 304 females were enrolled. All **304 participants were assessed for UGS**  
259 **but not all participants were diagnosed with FGS. Participants** were aged from 5 to 69 years old  
260 (193 of reproductive age, >13 and <70, with mean±SD age of 28 ±12.7). Also, 88.16% of  
261 participants were dependent on, and lived within a proximity of ≤200m to the Mape lake (Island  
262 communities), and the remaining 11.82% came from Mainland communities, which were further from

the lake (>400m), having alternative water sources (wells and stand taps), and involved in farming alone without fishing activities. A prevalence of 63.8% (194/304) for UGS was recorded from egg prevalence or hematuria. Furthermore, 27.30% showed proteinuria, and a 51.0% prevalence (155/304) was recorded for hematuria (with 19 showing macrohematuria). Microhematuria sensitivity and specificity was calculated against egg positivity, with a specificity and sensitivity of 80.00% (95% CI: 73.58 – 86.42) and 73.83% (95% CI: 66.91 – 80.75) respectively. The Geometric Mean Egg (GME) count was 33.1 (Range: 2 – 1220) among which 36.2% had heavy ( $\geq 50$  eggs/10ml of urine) infection while 63.8% had light (> 50 eggs/10ml of urine) infection. Macrohematuria was strongly related to egg density categories ( $\chi^2 = 17.7$ ;  $P < 0.001$ ), where cases of macrohematuria were directly related to heavy egg load (93.2%). More than half of the study population reporting not having received treatment with praziquantel in more than a year (see Table 1). Reported sexual and reproductive health syndromes included miscarriages (58.89%), lower abdominal pain (56.95%), lower back pain (44.59%), coital pain (45.98%), coital bleeding (37.93), vaginal itches (68%), abnormal vaginal discharge (42.6%) and menstrual irregularities (47.74%), all seen to be comparatively higher amongst participants, compared to stress incontinence (19.47) (see Table 1).

Table 1: General characteristics of all study participants (Sociodemographic, syndromic, clinical)

Variable	Category	Number of Women	Percentage
<b>1. Demographic</b>			
Age (groups) ( <i>n=304/304*</i> )	<14	111	36.51
	[14-19]	62	20.39
	[20-35]	83	27.3
	36+	48	15.79
Menarche( <i>n=304/304*</i> )	Pre	98	32.24
	Post	206	67.76
Age at marriage ( <i>n=178/193*</i> )	[13-14]	71	39.89
	[15-17]	88	49.44
	18+	19	10.67
No of Children ( <i>n=181/193*</i> )	0	44	24.31
	[1-3]	72	39.78
	[4-6]	37	20.44
	7+	28	15.47
Age of last child ( <i>n=130/137*</i> )	0+	10	7.69
	[1-3]	67	51.54
	[4-6]	15	11.54
	7+	38	29.23
Treatment with praziquantel ( <i>n=304/304*</i> )	< 12 months	1	0.3
	> 12 months	292	96.1
	Never	11	3.6
Economic Activity ( <i>n=241/304*</i> )	Fishing (with/without farming)	211	87.5
	Farming (without fishing)	30	12.4
Proximity to lake ( <i>n=304/304*</i> )	<200m	268	88.16
	>400m	36	11.84

<b>2. Syndromic</b>			
Lower Abdominal Pain( <i>n</i> =223/304*)	Yes	127	56.95
Coital Pain( <i>n</i> =174/193*)	Yes	80	45.98
Coital bleeding( <i>n</i> =174/193*)	Yes	66	37.93
Vaginal Itches( <i>n</i> =225/304*)	Yes	153	68.00
Vaginal Discharge( <i>n</i> =214/304*)	Yes	90	42.06
External genital Itch( <i>n</i> =206/304*)	Yes	86	41.75
Lower back Pain( <i>n</i> =223/304*)	Yes	99	44.59
Stress Incontinence( <i>n</i> =226/304*)	Yes	44	19.47
Menstrual Irregularities( <i>n</i> =199/206*)	Yes	95	47.74
Miscarriages( <i>n</i> =180/193*)	0	74	41.11
	1+	106	58.89
<b>3. Clinical</b>			
Parasitemia( <i>n</i> =304/304*)	0	141	46.38
	[1-50]	104	34.21
	50+	59	19.41
Hematuria( <i>n</i> =304/304*)	+	155	51.0
Proteinuria( <i>n</i> =304/304*)	+	83	27.30

\*Shows the eligible sample size for each variable. For age of marriage (*n*=178/193\*) for example, 178 out of the 193 eligible women gave information their marriage age, meaning 15 women had missing information for the variable.

### 1. UGS Characteristics amongst sample population

Table 2 presents the relationship between UGS as a dependent factor and each of the sociodemographic and reported reproductive health characteristics based on chi-square tests of independence and univariate logistic regression. The results indicate that the chances of UGS infection amongst women who lived more than 400m from the lake was 0.36 (95% CI: 0.17-0.72) times that of women who lived less than 200m to the lake, implying that significant odds of being infected with UGS was seen with closer lake proximity. A significant decrease in chances of infection with urogenital schistosomiasis was observed with increasing age. Relative to girls <14 years, girls between 14-19 years had a 0.46 (95% CI: 0.22-0.95) odds of having UGS, as opposed to 0.29 (95% CI: 0.15-0.54) odds for adults ranging from 20-35 years, and 0.09 (95% CI: 0.04-0.19) odds for women older than 35 years. All reported reproductive health syndromes showed significant relationship with UGS, except for stress incontinence (UOR 1.72 [95% CI: 0.87-3.54] *p*= 0.1287). In effect, women with lower abdominal pain, coital pain, vaginal itch, menstrual irregularity, and coital bleeding showed significantly higher odds (Table 2) of UGS.

**Table 2:** Relations between UGS and each socio-demographic and syndromic variable in the study sample

Chi2 test of Independence

Univariate logistic regression

Variables	Category	N	UGS – n (%)	UGS + n (%)	P-value	Unadjusted OR (95% C.I.)	P value
Age group (n=304)	<14	111	20 (18.2)	91 (46.9)	<0.0001	1	0.0352
	[14-19]	62	20 (18.2)	42 (21.6)		0.46 (0.22, 0.95)	
	[20-35]	83	36 (32.7)	47 (24.2)		0.29 (0.15, 0.54)	
	36+	48	34 (30.9)	14 (7.2)		0.09 (0.04, 0.19)	
No of Children (n=181)	0	44	15 (18.1)	29 (29.6)	0.0462	1	0.2143
	[1-3]	72	33 (39.8)	39 (39.8)		0.61 (0.28, 1.32)	
	[4-6]	37	16 (19.3)	21 (21.4)		0.68 (0.27, 1.67)	
	7+	28	19 (22.9)	9 (9.2)		0.25 (0.09, 0.66)	
Age of Last Child (n=130)	0+	10	4 (6)	6 (9.5)	0.0323	1	0.5863
	[1-3]	67	33 (49.3)	34 (54)		0.69 (0.16, 2.62)	
	[4-6]	15	4 (6)	11 (17.5)		1.83 (0.33, 10.6)	
	7+	38	26 (38.8)	12 (19)		0.31 (0.07, 1.27)	
Miscarriages (n=180)	0	74	41 (48.8)	33 (34.4)	0.1055	1	0.0382
	1	52	19 (22.6)	33 (34.4)		2.16 (1.05, 4.52)	
	2+	54	24 (28.6)	30 (31.2)		1.55 (0.77, 3.17)	
Lower Abdominal Pain(n=223)	Yes	127	42 (45.2)	85 (65.4)	0.0039	2.29 (1.33, 3.98)	0.0028
Coital Pain(n=174)	Yes	80	25 (30.5)	55 (59.8)	0.0001	3.39 (1.82, 6.43)	0.0001
Coital bleeding(n=174)	Yes	66	19 (23.2)	47 (51.1)	0.0002	3.46 (1.82, 6.79)	0.0002
Vaginal Itches(n=225)	Yes	153	51 (53.7)	102 (78.5)	0.0001	3.14 (1.77, 5.67)	0.0001
Abnormal Vaginal Discharge (n=214)	Yes	90	27 (29)	63 (52.1)	0.0008	2.66 (1.51, 4.76)	0.0008
Lower Back Pain(n=222)	Yes	99	34 (36.6)	65 (50.4)	0.0551	1.76 (1.03, 3.06)	0.0416
Stress Incontinence(n=226)	Yes	44	14 (14.7)	30 (22.9)	0.1729	1.72 (0.87, 3.54)	0.1287
Genital Itches(n=206)	Yes	86	26 (28.6)	60 (52.2)	0.0007	2.73 (1.53, 4.94)	0.0008
Menstrual Irregularity(n=199)	Yes	95	29 (33)	66 (59.5)	0.0002	2.98 (1.68, 5.4)	0.0002
Proximity to lake	<20m	268	89 (80.9)	179 (92.3)	0.0051	1	0.0042
	>200m	36	21 (19.1)	15 (7.7)		0.36 (0.17, 0.72)	

298

## 299 Multivariate Logistic Regression Model for Reporting Sexual and Reproductive Health (SRH) 300 Risk Factors related to UGS

301 After including all variables significantly related to UGS at a 25% level in a multivariate model,  
302 multicollinearity issues were suspected between lower abdominal pain and lower back pain, and external  
303 genital itch and vaginal itches. However, considering genital itch responses were most often related to  
304 vaginal itch or misreported by respondents due to their literal similarity in Pidgin English or Fulbe used  
305 during questioning, we resorted to keeping only vaginal itches in the model. Similarly for lower back  
306 pain and lower abdominal pain because of the similarity in responses, but with a more comprehensive  
307 responding for lower abdominal pain, lower back pain was removed. The resulting “best” fitting model  
308 included age group, lower abdominal pain, and coital pain as the most significant sexual and  
309 reproductive health risk factors for UGS (Table 3). In this result, we also observed a decreasing trend in  
310 number of cases of UGS with increasing age. Also, the odds of infection in women with lower abdominal  
311 pain was 6.42 (95% CI: 2.85 - 15.68) times that for women without the pain. The odds of infection in  
312 women with coital pain was 2.16 (95% CI: 1.05 – 4.46) times that for women without the pain.

313



314 **Table 3:** Possible risk factors for UGS amongst the socio-demographic and SRH included in the study.  
 315 A multivariate logistic regression model on the effects of sexual and reproductive health factors  
 316 significantly related to UGS.

SRH Indicator	Category	Adjusted OR (95% C.I.)	P value
Age group	[14-19]	1.0	
	[20-35]	0.28 (0.10, 0.70)	0.0087
	36+	0.11 (0.04, 0.31)	0.0001
Lower Abdominal Pain	No	1.0	
	Yes	6.42 (2.85, 15.68)	0.0000
Coital Pain	No	1.0	
	Yes	2.16 (1.05, 4.46)	0.0362

317

## 318 2. FGS Characteristics amongst study participants (Sub-group)

319 Of the total number of participants examined for FGS after UGS ( $n=67$ ), 40 were confirmed to have  
 320 ova-patent UGS, and 34 for FGS, upon the presence of homogenous yellow sandy patches, grainy sandy  
 321 patches, and abnormal blood vessels (Figure 2). A breakdown of UGS/FGS within the subset of 67  
 322 women examined for FGS showed: 26 FGS+/UGS+; 8 FGS+/UGS-; 14 FGS-/UGS+; and 19 FGS-  
 323 /UGS-. Related reproductive health syndromes (as reported in UGS), similarly, were all found to have  
 324 some association ( $P < 0.05$ ) with FGS manifestation amongst females (Table 4), except for stress  
 325 incontinence. Of import amongst these, menstrual irregularities or abnormality, also found with UGS,  
 326 was seen to have 7.9 times higher odds of affecting women with FGS than women without FGS (Table  
 327 4). Back pain was seen to significantly affect women with FGS manifestations than was the case with  
 328 UGS. Similarly, odds of having FGS manifestations were seen to ascend with age (Table 4), unlike UGS  
 329 which was significant with descending age. Lower abdominal pain, menstrual irregularity and lower  
 330 back pain showed the highest odds of manifesting amongst women with FGS.

### 331 Figure 2: Imagery of FGS pathology of the cervix with reported lesions (magnification x4)

332 **A)** 1-rubbery papule, 2-abnormal blood vessel, 3- homogeneous sandy patch (30-year-old woman,  
 333 +UGS, +lower abdominal pain, +Menstrual irregularity); **B)** 1,2- grainy sandy patches (45-year-old  
 334 woman, -UGS, +lower abdominal pain; +Menstrual irregularity)

335

336 **Table 4:** Relations between FGS and socio-demographic and syndromic variables in the sub-group of  
 337 girls and women diagnosed for FGS

Variables(n=67)	Category	N	Chi2 Test of Independence			Univariate logistic regression				
			FGS – n(%)	FGS + n(%)	P-value	Unadjusted OR (95% C.I.)		P value		
Age group	[14-19]	19	15 (45.5)	4 (11.8)	0.0091	1	(1.73, 26.1)	0.0077		
	[20-35]	29	11 (33.3)	18 (52.9)		6.14				
	36+	19	7 (21.2)	12 (35.3)		6.43			(1.62, 30.35)	0.0116
Age at Marriage	[13-14]	23	10 (30.3)	13 (38.2)	0.1286	1	(0.19, 1.58)	0.2765		
	[15-17]	38	22 (66.7)	16 (47.1)		0.56				
	18+	6	1 (3)	5 (14.7)		3.85			(0.51, 79.99)	0.2510
No of Children	0	16	12 (36.4)	4 (11.8)	0.0363	1	(0.64, 11.23)	0.2024		
	[1-3]	22	12 (36.4)	10 (29.4)		2.5				
	[4-6]	15	4 (12.1)	11 (32.4)		8.25			(1.79, 46.95)	0.0102
	7+	14	5 (15.2)	9 (26.5)		5.4			(1.19, 28.98)	0.0357
Age of Last Child	0+	1	1 (4.8)	0 (0)	0.1199	1	(0, Inf)	0.9965		
	[1-3]	27	14 (66.7)	13 (46.4)		Inf				
	[4-6]	4	0 (0)	4 (14.3)		Inf			(0, Inf)	0.9937
	7+	17	6 (28.6)	11 (39.3)		Inf			(0, Inf)	0.9963
Miscarriages	0	26	18 (54.5)	8 (23.5)	0.0362	1	(1.22, 13.78)	0.0256		
	1	22	8 (24.2)	14 (41.2)		3.94				
	2+	19	7 (21.2)	12 (35.3)		3.86			(1.14, 14.19)	0.0343
Lower Abdominal Pain	Yes	47	15 (45.5)	32 (94.1)	0	19.2	(4.74, 131.08)	0.0003		
Coital Pain	Yes	32	10 (30.3)	22 (64.7)	0.0071	4.22	(1.55, 12.16)	0.0058		
Coital bleeding	Yes	29	8 (24.2)	21 (61.8)	0.0029	5.05	(1.82, 15.19)	0.0026		
Vaginal Itches	Yes	49	18 (54.5)	31 (91.2)	0.0009	8.61	(2.44, 40.95)	0.0021		
Vaginal Discharge	Yes	32	9 (27.3)	23 (67.6)	0.0014	5.58	(2.01, 16.67)	0.0013		
Back Pain	Yes	41	12 (36.4)	29 (85.3)	0	10.15	(3.31, 36.45)	0.0001		
Stress Incontinence	Yes	10	0 (0)	10 (29.4)	0.0009	Inf	(0, Inf)	0.9927		
Genital Itch	Yes	32	9 (27.3)	23 (67.6)	0.0014	5.58	(2.01, 16.67)	0.0013		
Menstrual irregularities	Yes	34	9 (27.3)	25 (73.5)	0.0002	7.41	(2.61, 23)	0.0003		
Proximity	<20m	60	30 (90.9)	30 (88.2)	1	1	(0.27, 7.25)	0.7212		
	>200m	7	3 (9.1)	4 (11.8)	1	1.33				

338

### 339 Multivariate Logistic Regression Model for Reporting Sexual and Reproductive Health (SRH) 340 Risk Factors related to FGS

341 Similar to UGS, a multivariate model was constructed with all variables significantly related to FGS at  
342 a 25% level. As well, multicollinearity checks revealed lower back pain and genital itch (for same  
343 reasons) with the variables age group, coital pain, vaginal itches, and lower abdominal pain (Table 5)  
344 retained in the “best” fitting model.

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347 **Table 5:** Possible risk factors amongst SRH for FGS. A multivariate logistic regression model on the  
348 effects of FGS on sexual and reproductive health factors.

SRH Indicator	Category	Adjusted OR (95% C.I.)	P value
Age group	[14-19]		
	[20-35]	20.15 (2.92, 240.94)	0.0061
	36+	41.29 (4.16, 946.69)	0.0054
Coital Pain	No	1.0	
	Yes	10.44 (2.12, 90.91)	0.0105
Vaginal Itches	No	1.0	
	Yes	12.50 (1.92, 128.77)	0.0151

Lower Abdominal Pain	No	1.0	
	Yes	28.80 (3.36, 578.24)	0.0081

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### 3. UGS, FGS and associations with reproductive health characteristics

Age, number of children, age of last child, menstrual abnormality, miscarriages, and lower abdominal pain were identified as possible reproductive health factors associated with *S. haematobium* infection and were used within this study. Generally, both FGS and UGS were not significantly ( $P$ -value  $>0.05$ ) related to number of children, age of last child and miscarriages. In multivariate logistic regression models, after selection of the best fitting models, the results show that the most significant risk factors for UGS are age group, lower abdominal pain and coital pain (Table 4), whereas age-group and lower abdominal pain, coital pain and vaginal itches were identified as the most significant risk factors for FGS (Table 5). Chances of FGS manifestations amongst women with lower abdominal pain was AOR 9.5 (95% CI: 1.7-81.8) times that of women without the pain (Table 5). Analysis of deviance tables for both best fitting models (FGS and UGS), with  $p$ -values based on likelihood ratio tests are reported in Supplementary File 2.

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### Discussion

Understanding the risks and associations of UGS and FGS, especially within different contexts of women's health [41, 50], sheds greater light on the disease epidemiology, which could foster improved and coordinated control measures both locally and nationally [41]. Furthermore, precisely documenting existing associations between both UGS and FGS could clarify further the need for precision mapping of schistosomiasis in endemic regions, for formulating a better targeted integrated response [48]. Though a non-significant association was observed between egg intensity in urine and FGS from the onset of this study (Table 2), parasitemia association has been shown to be misleading in UGS [7, 12, 13] from several other studies [13] and reports on FGS, particularly when only a single urine sample is examined which is usually the case for population-based surveillance [6]. Considering this, questionnaire (for symptoms) [10, 21], as well as visual examination of cervix and vaginal walls by colposcopy [12, 18,

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3 374 51], offers an added strength to single sample urinalysis for detection of FGS, as carried out in this study,  
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5 375 and several others[10, 18]. The possibility of the presence of FGS in UGS populations has been often  
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7 376 raised[8, 21], with projections of about 360 million girls and women possibly having UGS[15], but today  
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9 377 it is thought that at least 56 million adolescent girls and women are suffering from FGS[15, 17]. Our  
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11 378 results seem to show an even higher rate of FGS amongst the UGS infected population with an  
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13 379 approximate FGS/UGS ratio of 34/40. Our study, given our application of portable colposcopy, is the  
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15 380 first formal attempt to document the pathology of FGS in a primary care setting in Cameroon.

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18 381 Elsewhere, the clinical pathology of FGS has been described resulting from the complex inflammatory  
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20 382 responses to antigens released by adult worms and viable eggs[6, 14], which persists until sometime  
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22 383 after adult worms are stopped egg-laying or are destroyed by praziquantel[24]. Thereafter, various signs  
23  
24 384 and symptoms (or effects) may present months or even years after treatment[23, 42].

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26  
27 385 From present results, and within the general literature[15, 17], one of such effects noted is an effect on  
28  
29 386 menstrual health. More than half of women within the study who reported poor menstrual health (FGS  
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31 387 = 73.5%; UGS = 54.6%), either as irregular, painful or seized menstruation, were found to either shed  
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33 388 eggs in urine (positive for UGS), or were positive for FGS, but without eggs in urine; showing more  
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35 389 women positive for FGS reporting abnormal menstruation, than for UGS. This confirms recent  
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37 390 analysis[17, 33] and suggests strong linkages between menstrual health management and FGS[15, 17],  
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39 391 an under researched area. This can be credited to the fact that symptoms perhaps diminished after a  
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41 392 while with UGS (maybe as a result of treatment in mass drug administration campaigns), but later  
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43 393 resurface with more chronic sequelae of FGS[17], and with more dire symptoms and negative impact  
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45 394 on menstrual health[17, 33]. In our study context, post-menarche females already faced a substantial  
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47 395 challenge with limited access to hygienic material and information on menstrual health management,  
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49 396 typically relying on self-made clothes and absorbent plant leaves during menstruation, due to lack of  
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51 397 finances or general knowledge.

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54  
55 398 Still related to FGS and menstrual health, narratives from a previous study[33] which used qualitative  
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57 399 probing showed women having manifestations of FGS and not shedding eggs in urine, gave a history of  
58  
59 400 having lived in their earlier years in heavily infested *S. haematobium* foci. This explained their later

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3 401 manifestation of FGS symptoms, even after having moved away to a less infested area, with more than  
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5 402 90% limit in fresh water contact[33]. This is similar to our findings, where lake proximity was seen to  
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7 403 be not very significant to FGS manifestation (Table 4), same as egg shedding, still pointing to early-in-  
8  
9 404 life infection and later chronicity. Significant difference in menstrual abnormalities amongst UGS  
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11 405 positive women [n=22 (56.4%)] and UGS negative women [n=12 (44.4%)], alerts to future chronicity  
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13 406 of FGS after UGS, especially if not managed with more readily available praziquantel treatment(s)[42,  
14  
15 407 52].

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18 408 On its own, lower abdominal pain observed significant association (in adjusted and unadjusted  
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20 409 regression models) in both UGS and FGS. The chances of having lower abdominal pain were  
21  
22 410 significantly higher in females with either FGS (94.1%) or UGS (84.2%). Similarly with coital pain and  
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24 411 vaginal itches, these reported as key indicators for UGS and FGS, directing early diagnosis of UGS and  
25  
26 412 future FGS in endemic communities, thereby promoting the verticalization of control strategies for both  
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28 413 diseases.

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31 414 Another trend observed in this study is that intensity of infection or egg patent-prevalence (for UGS)  
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33 415 reduces while chronic disease or morbidity for FGS increases as women age. The chances of FGS after  
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35 416 UGS increased significantly (AOR 6.43,95% C.I 1.62-30.35, P=0.0091) as women aged (36+). Similar  
36  
37 417 findings have been reported in other studies in different geographical locations[6, 14, 53, 54] and  
38  
39 418 recently in this area[33]; emphasizing on the level of present intensity for UGS, and possible future  
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41 419 occurrence of FGS[14, 54]. UGS at a younger age will in some cases manifest into FGS when the female  
42  
43 420 is older[14], causing more intense gynecological symptoms and effects. This offers a possible guiding  
44  
45 421 tool for better control policies, related to early diagnosis and treatment[41, 55]. This surpasses need  
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47 422 alone for school-based MDAs[13, 28, 56], but considers and encourages individual therapy in different  
48  
49 423 contexts for FGS (and MGS)[6].

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52  
53 424 Although only a few amongst the extensive list of reproductive health determinants [54] were identified  
54  
55 425 in this study to be statistically significant, where mostly reported symptoms were collected, clinical and  
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57 426 biological examinations carried out, enabled confirmation of how future self-reported symptoms with  
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59 427 UGS and FGS might be best used[33]. These results support the advocated need for further attention on

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3 428 post-transmission schistosomiasis[57], and also, the availability of praziquantel in lowest level (Health  
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5 429 Areas and community) health care for individual therapy[54], as well as treatment from a younger  
6  
7 430 age[15, 28, 41, 52], buoyed with the recent development of pediatric praziquantel[58].  
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### 10 431 **Study Limitations**

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12 432 Though described as gold standard[49], active UGS was only detected through observation of eggs in  
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14 433 urine samples by microscopic-based poly-carbonate filter examination, as well as recommended dipstick  
15  
16 434 assays for urinary hematuria detection. Alternative molecular assays such as polymerase chain reaction  
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18 435 (PCR) for schistosome detection in human serum and urine samples[12], were not considered for added  
19  
20 436 sensitivity for UGS and FGS (in vaginal lavage analysis)[3, 59]. Though recommended[12, 21], only  
21  
22 437 visual examination through inspection for lesions on the cervix, the fornices, and the vaginal walls with  
23  
24 438 a colposcope[5, 51] and screening with questionnaires[10] was considered in the detection of FGS in  
25  
26 439 this study. Lastly, clinical diagnosis of FGS was carried out only on a limited sub-group of females,  
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28 440 where more precise conclusions may be obtained by using an appropriate sample size.  
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### 32 441 **Conclusion**

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35 442 Whilst millions of women in Cameroon have UGS, its epidemiological connection with FGS is not  
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37 443 fully appreciated, which creates an unfortunate knowledge holdup for effective control at the public  
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39 444 health level. In our chosen study location, which is broadly typical for endemic areas of UGS in  
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41 445 Cameroon[21, 34, 36, 40], strong epidemiological associations between UGS and FGS were found  
42  
43 446 against certain key sexual and reproductive determinants: age, lower abdominal pain and menstrual  
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45 447 health. This formative knowledge could be utilized to tackle and ultimately prevent FGS, with a more  
46  
47 448 targeted integrated control for UGS in Cameroon and elsewhere in endemics areas for UGS globally.  
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49 449 This study further adds detailed insight into the connection of FGS and UGS within primary care in  
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51 450 endemic communities, denoting those with cardinal symptomologies more explicitly for scalable  
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53 451 detection and targeted control of FGS within UGS endemic areas.  
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### 58 453 **Supporting Files**

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2  
3 454 Supplementary File 1.docx : Structured questionnaire

4  
5 455 Supplementary File 2.docx: Deviance Table

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10 457 **Declarations**

11 458 • **Authors' contributions**

12  
13  
14 459 MCM and JRS conceptualized the study and planned the methodology; AEN, VG, MCM, carried out  
15  
16 460 field investigation; FNB, MCM, JRS, ASO, AEN, VG, analyzed and interpreted the data for this  
17  
18 461 manuscript; MCM acquired funding for study and wrote the original draft of the manuscript; JRS  
19  
20 462 supervised the study and was a major contributor in the conceptualization and writing of the manuscript;  
21  
22 463 AEN, coordinated field activities within the Malantouen Health District; AEN, FNB, VG, ASO,  
23  
24 464 reviewed and edited the manuscript. All authors approved the final version of the paper before  
25  
26 465 submission.

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33 467 • **Competing interests**

34  
35  
36 468 The authors declare that they have no competing interests.

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51  
52 475 decision to publish, or preparation of the manuscript.

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2  
3 477 All data generated or analysed during this study are included in this published article [and its  
4  
5 478 supplementary files].  
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3 504 • **Consent for publication**  
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5

6 505 Written informed consent for publication of clinical details and/or clinical images was obtained from  
7  
8 506 the patients and parents/guardians where needed.  
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14 508 **References**  
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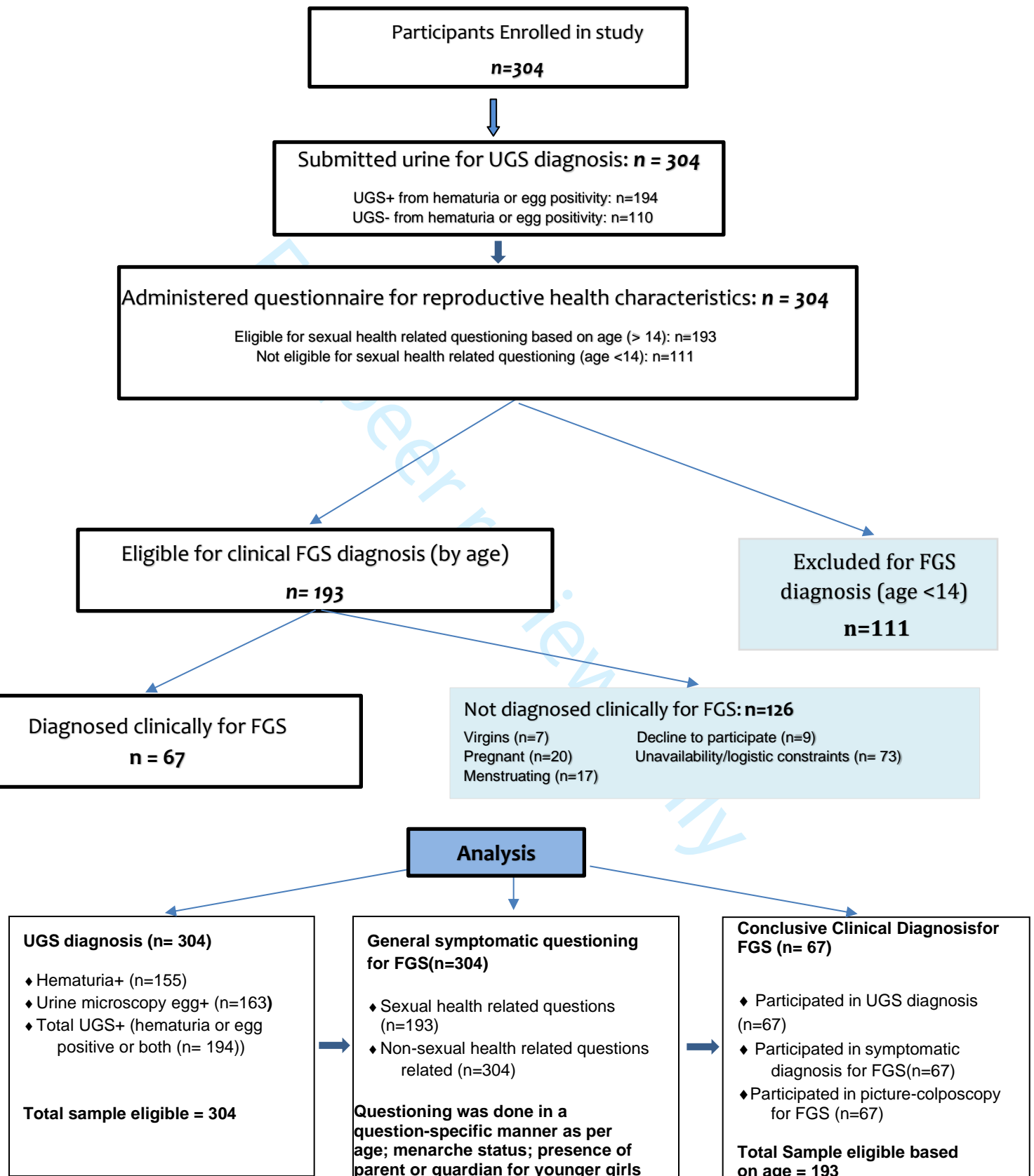
22 666 • **Figure Legends**

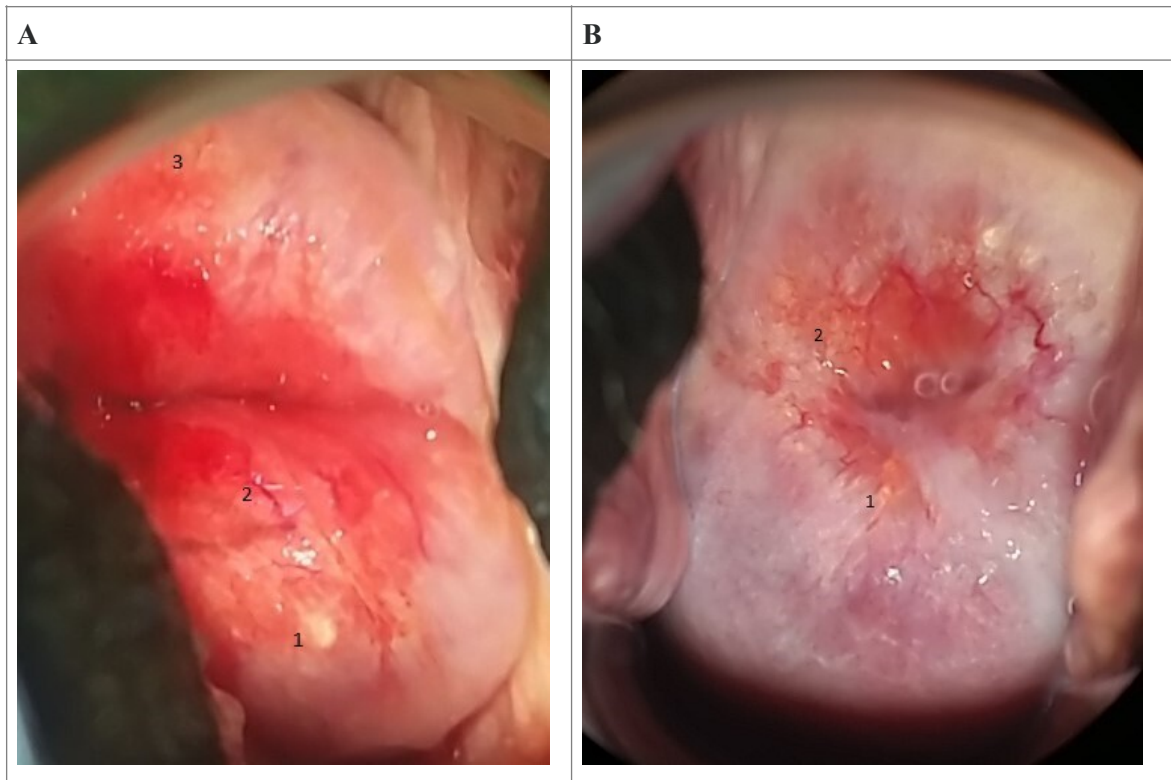
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24 667 **Figure1:** Study participant selection criteria and numbers with diagnostic methods flow

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26 668 **Figure 2:** Imagery of FGS pathology of the cervix with reported lesions (magnification of x4)

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28 669 **A)** 1-rubbery papule, 2-abnormal blood vessel, 3- homogeneous sandy patch (30-year-old woman, +UGS, +lower  
29 670 abdominal pain, +Menstrual irregularity); **B)** 1,2- grainy sandy patches (45-year-old woman, -UGS, +lower  
30 671 abdominal pain; +Menstrual irregularity)  
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## Sampling Flow Diagram





## Supplementary File 1

Close-ended structured questionnaire**A. Close ended structured questionnaire– Administered directly in English with oral translations into Fulbe, Kotoko, Mosgum, and Arab**

Name of Community: \_\_\_\_\_

Age (years): \_\_\_\_\_

Education: Informal education ( ) Formal education ( ) (specify) \_\_\_\_\_

Marital Status: Single ( ) Married ( ) Separated ( ) Widowed ( )

No of years having lived in community \_\_\_\_\_

Previous community \_\_\_\_\_

Economic activity-----

Residence ----- (collect coordinates)

**Questions on symptoms of urinary tract schistosomiasis; FGS; OR STI**

1. Do you see your menses? Yes ( ) No ( )
2. Did you observe/experience your menses within the last two weeks? Yes ( ) No ( ) Does your menses come every month? Regular?
3. Is your menses painful? \_\_\_\_\_(pain during menstruation – always very painful, sometimes painful, normal) Irregular? \_\_\_\_\_(every month?, not every month, stopped)
4. Do you have pain in your lower abdomen? When? For how long?
5. Do you have pain when urinating? Yes ( ) No ( )
6. Do you have difficulty in urinating (urine not coming out fluently)? Yes ( ) No ( )
7. Do you have sudden uncontrollable and unexpected urge to urinate and mostly cannot hold it? Even when you cough it comes out? Yes ( ) No ( )
8. Do you see blood in your urine? Yes ( ) No ( )
9. (If yes) When did you lastly see blood in your urine? \_\_\_\_\_Always, sometimes, Once in a while
10. Do you sometimes haveitching in your private part?Yes ( ) No ( )
11. How often do you experience this? Once a while ( ) frequently ( )/ When was the last time?
12. Do you have a feeling of burning within your private part? Yes ( ) No ( )

1  
2  
3 13. How often do you experience this? Once a while ( ) Frequently ( )  
4

5 14. Do you sense a swelling/lumps within your private part? Yes ( ) No ( ) No response ( )  
6

7 15. Do you have any discharge that comes from your vagina? Yes ( ) No ( ) Does it have an odour?  
8

9 \_\_\_\_\_ Do you see the colour? Yes ( ) No ( ) What Color is it? White; grey; green/yellow;  
10

11 brown  
12

13 16. Do you think this is normal? Yes ( ) No ( ) Do not know ( ). When did you start observing the  
14 discharge? Date \_\_\_\_\_  
15

16 17. After sexual intercourse do you have a discharge? Yes ( ) No ( ) Is it smelly? Yes ( ) No ( ) Do not  
17 know ( )  
18

19 18. After or during sexual intercourse do you have pain? Yes ( ) No ( ) I do not know ( ) ; Do  
20 you have a bloody discharge? Yes ( ) No ( ) I do not know ( )  
21

22 19. Have you had any miscarriages /pregnancies that passed? Yes ( ) No ( )  
23

24 20. How many? ( )  
25

26 21. Do you have children? Yes ( ) No ( )  
27

28 22. What age is your last child? ( )  
29

30 23. Have you visited the clinic to complain about these issues? Yes ( ) No ( )  
31

32 24. What you used/taken/done to treat any of these problems? \_\_\_\_\_ (Underline) Hospital  
33 or drug store/ local midwife/ traditional medicine/ prayers/ none of the above (what other?  
34 Specify)/nothing  
35  
36

### 37 **Water contact History**

38 1. Where do you fetch your household water? Lake; other source (name) \_\_\_\_\_  
39

40 2. Do you fish in the lake? Yes ( ), No ( )  
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42 3. Do you bathe in the lake? Yes ( ), No ( )  
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44 4. What do you use the lake for? ( ) \_\_\_\_\_  
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## Supplementary file 2

**Analysis of deviance tables for both best fitting models (FGS and UGS), with *p*-values based on likelihood ratio tests**

Variable	Df	Deviance	Resid. Df	Resid. Dev	Pr(>Chi)
<b>UGS</b>					
Age2	2	19.0094	162	208.70	7.450e-05 ***
Lower Abdominal Pain	1	25.6949	161	183.01	3.999e-07 ***
Coital Pain	1	4.4254	160	178.58	0.03541 *
<b>FGS</b>					
Age2	2	9.8057	64	83.061	0.0074253 **
Coital Pain	1	11.3146	63	71.747	0.0007690 ***
Vaginal Itches	1	13.1740	62	58.573	0.0002839 ***
Lower Abdominal Pain	1	10.5961	61	47.976	0.0011333 **

**STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology\***  
**Checklist for cohort, case-control, and cross-sectional studies (combined)**

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-6
Objectives	3	State specific objectives, including any pre-specified hypotheses	6
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	7-10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	8-9
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	/
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-11
Bias	9	Describe any efforts to address potential sources of bias	/
Study size	10	Explain how the study size was arrived at	7-9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9-10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9-10
		(b) Describe any methods used to examine subgroups and interactions	10
		(c) Explain how missing data were addressed	7-8
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	/

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	/
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-13
		(b) Give reasons for non-participation at each stage	7-8
		(c) Consider use of a flow diagram	7
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11-13
		(b) Indicate number of participants with missing data for each variable of interest	/
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	/
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	/
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	/
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	11-13
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9, 12-15
		(b) Report category boundaries when continuous variables were categorized	9, 12-15
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	/
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	/
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	18-20
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	21
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21
Generalisability	21	Discuss the generalisability (external validity) of the study results	21
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	22

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).